POWER

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Time to Revamp

RESEARCH, invention and experience have done a great deal for the power plant in the last quarter of a century.

Have you profited by the progress?

There were boilers twenty-five years ago and more that were doing as well in pounds of water evaporated per pound of coal as any but the most exceptional boiler plants today, but such performances were not common in the old hand-fired plants and are not usual in the majority of plants now running.

Improvement in boiler and furnace design, in materials and apparatus for maintaining efficiency and continuity of operation, the development of machinery for performing the grilling and arduous work of the fireman for handling fuel and ashes and keeping the heating surfaces clean, of indicators and guides for the operator and records for the engineer and manager have made the maintenance of creditable records easily possible with obtainable boiler-room help.

The diffusion of knowledge of the principles of combustion, the instruments and appliances available for the control of boiler-room operations and the machinery that has been developed to make the carrying out of those operations easy and convenient, have made it reasonable to expect a higher return upon the money that is invested in the coal pile.

And much of this has made it possible to use to advantage coals that can be had for less money than the higher grades necessary to keep the plant going under the old régime.

Boilers can be run at much higher rates than was thought possible without reduction of efficiency, reducing the necessary investment and standby losses. Heat allowed to escape by the chimney can be saved.

And in the use of steam after it has been made what improvements have been developed! Modern simple engines will run on as little steam as the condensing compounds of a few years ago. Higher pressures and superheat and the avoidance of cylinder losses have made this possible. Convenient forms of material and appliances for preventing heat wastes from radiating surfaces and formerly untrapped outlets are at everybody's hand. Electrical transmission has made it possible to distribute the power of the prime mover efficiently and conveniently to any corner of the works.

There comes a time when any machine or plant has had its day, is through with its best service and has been outstripped in effectiveness and efficiency by the progress in the art. Would it not be wise to consider how much you have on your own hands that is costing you money by its obsolescence?

F. R. Low

Machine Equipment of Realty Manager Ice Plant

Motor Driven Duplex Double-Acting Compressor—Turbo Blowers for Air Agitation—Spray Pond on Roof—Low Power Consumption Obtained

WHEN The Realty Managers, Inc., proposed to install equipment for the manufacture of ice, on a site at 170th Street and Inwood Ave., in the Bronx section of New York City, the owners visited a number of ice plants for the purpose of studying the various types of equipment. As a result of this investigation they decided to install duplex, horizontal medium-speed compressors with direct-connected synchronous motor drive. With the low electric rate that is obtainable by ice plants in New York City, they expected to secure a very economical plant with respect to power consumption and a cheap plant to operate with reference to the labor cost per ton of ice.

One of the striking impressions that the visitor gets is that the tank room and the engine room are on the same level and that the engine room is not encumbered with those small and noisy auxiliaries units as is frequently the case.

This feature becomes possible owing to the natural slope in the property between Cromwell Avenue, where the engine room is located, and the loading platform at the opposite end on Inwood Avenue, amounting to about five or six feet. The ice which is harvested on the tank room floor slides gently down the ice chutes into the daily storage room, a drop of about two feet. The daily storage room floor is, therefore, about four feet above grade at the point where the trucks receive their ice.

Before actual building operations were begun, it was learned by test borings that an old ash fill existed on the property to a depth of about 30 ft. Inasmuch as it would be necessary to excavate to this depth for the building wall foundations and the compressor foundations, it was also decided to excavate the whole property and locate a large ice storage room beneath the plant, equipped with the latest type of lowering and hoisting apparatus.

Motor-Driven Compressors

There are at present in the engine room two twin-cylinder double-acting compressors arranged duplex and directly driven by direct-connected synchronous motors. The cylinder bore in each case is 12 in. and the stroke 18 in., and together the machines are rated to produce 100 tons of ice a day, although they have exceeded this by a considerable margin. Each cylinder is equipped with duplicate oiling systems, one a force-feed lubricator for the ammonia oil to the cylinder and gland and the other a gear pump providing lubricating oil through sight cups to the main bearing, the crankpin bearing, the wristpin and to the crosshead guides.

The synchronous motors are rated at 190 hp. at a speed of 109 r.p.m. and operate on 440-volt three-phase 60-cycle current. The rotors are of split construction, and the shafts of the compressors are of sufficient length to allow the rotors to be removed without dismantling the compressors by sliding the stator on its sole plates. Moreover, the correct flywheel effect has been built into the rotors in order to keep the current pulsations within specified limits when operating the machines on either one or two cylinders. With this feature and by disengaging one connecting rod, it is possible to secure the maximum of compressor flexibility under any existing operating conditions.

The starting equipment for these motors is of the full automatic type with push-button control. These buttons are mounted on the wall of the engine room close to the machines, while the switch panels are placed in a mezzanine basement directly beneath and include the necessary contactors, overload and no-voltage protection and frequency relays.

Condensers Use Spray-Cooled Water

The ammonia condensers, Fig. 4, are of the conventional atmospheric type, with 18 sections, each 12 pipes high and about 20 ft. long. They are on the roof of the daily storage room and receive cooling water through a header system connecting with the roof of the tank room about 12 ft. higher than the daily storage room roof, where there is located the spray cooling system, Fig. 1, surrounded by vertical louvers of Monel metal.

Alongside of the condensers are mounted two additional sections 12 pipes high and 20 ft. long, which serve as liquid coolers. These sections are connected in the liquid line between the ammonia receiver and the several expansion valves in the plant and serve to reduce the temperature of the outgoing liquid to within one or two degrees of the temperature of the water going over the condensers from the spray cooling system. The water-distributing arrangement for all sections consists of a 2-in. slotted pipe at the top of each stand. These pipes are suspended at each end by bronze bolts for leveling purposes in order to secure a uniform flow of water at all points.

The spray cooling nozzles which supply the condensers receive their water from two motor-driven direct-connected centrifugal pumps in the basement beneath the main engine-room floor. One of these pumps has a capacity of 1,000 and the other of 500 gal. per min. After the water has passed over the condensers, it is collected in a surge tank which is connected to the pump suctions. This surge tank also receives the discharge from the compressor water jackets and has an overflow to the sewer to guard against sudden rainstorms in the summer. It is also equipped with a float-type water-level regulating valve. With these precautions there is always in the system the correct amount of cooling water.

The suction headers for the two centrifugal pumps are connected with the bottom of the surge tank and so arranged that either or both pumps can be used for circulating purposes, and a corresponding discharge-

Fig. 1—Spray cooling system is on roof

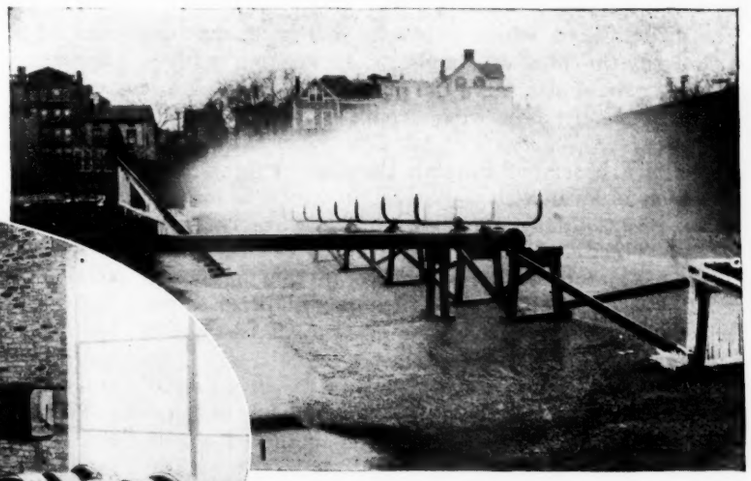
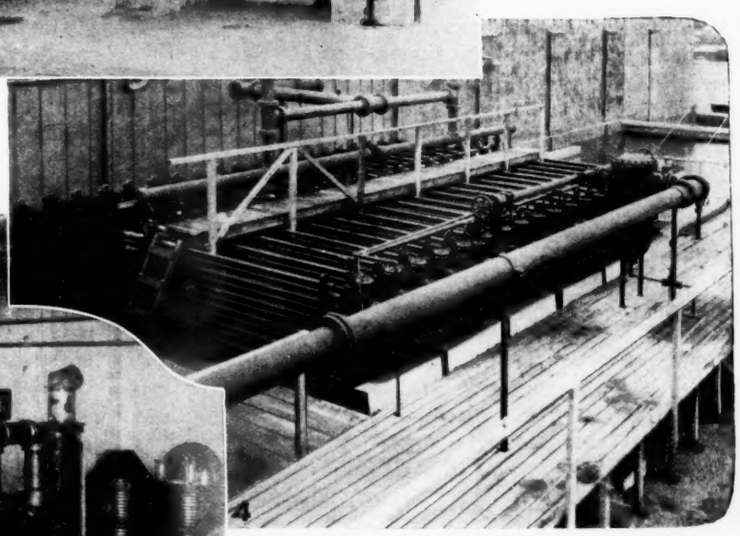


Fig. 2—Control board and exciters are in compressor room

Fig. 3—Unaflow double-acting twin compressors are motor driven



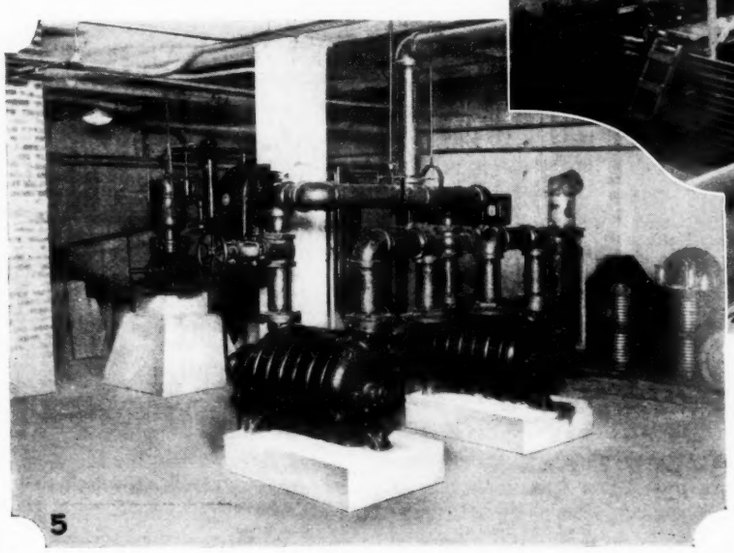


Fig. 4—Atmospheric condensers and liquid coolers

Fig. 5—High-speed turbo-blowers supply agitation air

pipe arrangement is provided for between the pump-discharge connections and the spray-nozzle headers.

The switchboard, which is shown in Fig. 2, was designed with the idea of simplicity in keeping with a board that would also serve the plant to the best advantage as completely as possible from an operating point of view.

There is a basement beneath the main engine-room floor which is level with the street in which is located most of the auxiliary apparatus. There are two six-stage turbo-blowers, Fig. 5, direct connected to 8½-hp. 3,600-r.p.m. motors. There are also in this basement two single-cylinder 6x6-in. air compressors belted to 5-hp. induction motors. These supply the air needed by the pneumatic hoists on the cranes.

The 150-r.p.m. pump which transfers the brine from an ice tank during the thawing operation to the pipe coils in the storage-water tank is also in the basement and is of the direct-connected centrifugal type with a 5-hp. motor. A boiler to heat the building is provided with oil-burning equipment consisting of a bronze oil pump of the gear type and a blower of the rotary positive-pressure type, both of which are constructed as a unit and belt-connected to a one-horsepower motor. From this unit the air and fuel pipes, with ample relief valve and bypass protection to accord with the regulations of the New York City Fire Department, run to the boiler and to the oil tank beneath the sidewalk outside of the building. The automatic starting panels for the synchronous motors are mounted directly beneath the motors in this basement and require practically no attention.

The power for this plant is furnished at a voltage of 13,200, three-phase, 60 cycles. The power company has connected one substation with the other, looping the cables through this ice plant and several others on the same circuit in turn. There is a truck-type switch provided in a room set off for the power company's equipment, from either of which the plant may receive its power in case of emergency, but normally both switches are closed and the substations are tied together through the ice plants. A third truck-type switch, also belonging to the power company, is mounted alongside of these two and carries the power company's metering equipment. From this meter panel and switch the high-tension current goes to a truck-type switch belonging to the Realty Managers, which is the fourth unit located in this room. This panel is for the customer's use and serves to disconnect the plant from the power company's lines completely.

From here the high-tension wires run to the transformer room which is adjacent and to three 333-kva. oil-cooled transformers, a fourth transformer being provided for use in case of emergency. This transformer room is properly ventilated and of generous proportions. The busbars from the low-tension side of these transformers connect directly with the switchboard in the engine room, taps being taken off these busbars for the small lighting transformers which operate the lighting circuits throughout the whole building.

The building as now standing was designed to accommodate equipment for the manufacture of 200 tons of ice per day. The present equipment was installed with the intention of producing 100 tons of ice per day, or one-half the ultimate rated capacity, and the plant is actually producing in excess of 125 tons per day.

The piers for the columns beneath the ice tanks and the compressor foundations are now in place for the additional equipment, which can be installed quickly at any time the conditions warrant. The water fore-cooling tank, the transformers, the water pipe, ammonia suction and liquid lines, as now installed, are all the required size for the ultimate capacity of the plant and will not need to be changed when the additional equipment is ordered. Moreover, all auxiliaries are duplicated.

The building was erected by the owners, and all equipment and ice-making apparatus throughout, including the electrical work, the transformers, switchboard, and of course the freezing room and compressors were furnished and installed by the Arctic Ice Machine Company. The freezing system is what is known as the Arctic Pownall Stationary Can System.

The labor of operating the plant is reduced to a chief engineer, three watch engineers and three tank men. As a consequence the labor item per ton of ice is quite low. During the winter, when the condensing water is around 40 deg. F., the power per ton of ice is approximately 33 kilowatt-hours.

PRINCIPAL MACHINERY OF THE REALTY MANAGERS, INC., ICE PLANT

Ammonia Compressors	Arctic Ice Machine Co.
Cylinder dimensions	12 in. bore by 18 in. stroke
R.p.m.	109
Drive	190-hp. synchronous motors, direct connected
Make of Motors, Exciters and Switchboard	Elec. Machinery & Mfg. Co.
Air Compressors	Gardner Gov. Co.
Cylinder dimensions	6-in. bore by 6-in. stroke
R.p.m.	1,200
Drive	Belted to 5-hp. Induction Motor
Air Blowers	General Elec. Co.
Capacity, c.f.m.	350
Pressure, discharge, lb. per sq.in.	3
Drive	Direct connected to 8½-hp. G.E. Motor
Brine Pump (1)	Allis-Chalmers Mfg. Co. Centrifugal
Capacity, gal. per min.	100
Drive	Direct connected to 5-hp. 1750 r.p.m. Allis-Chalmers Motor
Water Pump (2)	Allis-Chalmers
Capacity, gal. per min	One 500 and one 1,000
Drive	Direct connected to a 15-and a 25-hp. 1,750-r.p.m. Allis-Chalmers motor
Ice elevator	Gefford Wood Co.
Drive	Belted to motor
Water Tank, Precooling (1)	Arctic Ice Machine Co.
Size	8 ft. dia. by 24 ft. high
Direct expansion coils	1,640 ft. of 2-in. block pipe
Brine Thaw Coil	984 ft. of 2 in. galvanized pipe
Condensers	Arctic Ice Machine Co.
Type	Atmospheric
Size	16 sections of 12 pipes 20 ft. long
Tonnage rating	160
Liquid cooler	Arctic Ice Machine Co.
Spray Cooling System	Brinks Spray Equipment Co.
No. of nozzles	24
Capacity, g.p.m.	1,000
Freezing Tanks (18)	Arctic Ice Machine Co.
Cans per tank	84
Size of cans	11 x 22 x 47 in.
Brine Cooling System (2)	Arctic Ice Machine Co.
Size of coolers	46 in. dia., 12 ft. long
Area of surface, sq.ft.	3,000
Brine agitators (2)	Arctic Ice Machine Co.
Type and size	Vertical; 18 in. dia.; 18 in. pitch; 3-blade
Driving motors	Cleveland Elec. Motor Co., 10-hp., 900 r.p.m.
Crane (2)	Arctic Ice Machine Co.
Capacity, lb.	2,000
Room insulation	Armstrong Cork & Insulating Co.
Pipe insulation	Keasby Malleson Co.
Roof covering	Carey

Some Practical Comments on Power-Plant Logs

By WILLIAM E. GRAY
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MOST engineers see the advantage of keeping records, but hardly any two agree as to what records should be kept and, particularly, what forms should be used. Mr. Gray offers a carefully prepared boiler-room operating log as a standard for the small plant. What do you think of it?

MOST systems of records kept in power plants today are the result of individual experience in the particular plants they serve. This has naturally resulted in variations in the systems used, some of which are caused by a difference in needs and some by peculiarities of different individuals.

In preparing the most efficient system of records for any power plant, we should be guided by a knowledge of what purpose those records should serve. Industrial engineers tell us that records serve two purposes—they furnish information to guide the management, and they furnish information from which to compute costs. These statements are just as true of power-plant records as they are of business records. They indicate that a standard system of power-plant records can be evolved that is applicable in any power plant. The details of the system can be adjusted to suit the size and needs of the particular plant, just as is done in business. Every business of any importance has its daybook and its ledger, the entries being varied to suit individual needs.

Simplicity an Essential

Any system of records must be simple, and we must keep one thing in mind in working up a system of power-plant records—the men who will be largely responsible for keeping these records have not had much training in that line. A business house hires clerks and bookkeepers to compile its records, but in a power plant it is neither possible nor desirable to do so. Necessarily, the information must be gathered by men whose primary duties are of another nature, and we must not forget that if the duty of record taking encroaches too much upon the primary duties, the record taking will suffer. A few reliable records are of vastly greater value than a mass of unreliable ones, so where it becomes necessary to make a choice, quantity will have to be sacrificed for quality.

The aim of any manager is to operate his business at the highest possible efficiency, for in that way alone can he successfully meet competition. Efficiency has a very tangible meaning to the power-plant manager, so it is not a hard matter to decide what items should go into the records. The best method of taking records of those items will depend upon individual needs. The two methods available are by human observation and by mechanical recorders. A choice can be made on a cost basis if all items are considered. The cost items to be considered for mechanical recorders are first cost of instrument and cost of upkeep. The items to be considered for human observation are the time required to be spent in taking records and the gain or loss due to difference in accuracy of results secured from the two systems.

Must Prevent Recording from Memory

No attempt will be made in this article to discuss the differences in recording instruments that are available. The writer merely wishes to point out the availability of this method. However, some difference exists in the methods of recording human observations. The most common way seems to be to furnish the operator with a ruled form of sufficient size to contain all the readings taken by that operator during his shift, and frequently one sheet is large enough to contain the readings for the three shifts of the day.

This system is open to several objections. First, it is necessary that this sheet be kept at some one place in the plant. Those readings that cannot be made from this point are made by the operator on his rounds and then entered from memory when he gets back to this sheet. Aside from the danger of entrusting a number of readings to memory even for a short time, this system is likely to encourage the habit of putting down readings without taking the trouble to see what they are. Again, most of these forms in use contain space for readings that experience has taught are not worth making, and those columns are left blank. This is not especially desirable either, as it is likely to engender a spirit of carelessness in making other readings. The only point in favor of this system is that it collects all the readings of one operator on one sheet, this supposedly making the permanent record. But unless especially care is taken, these sheets become dirty in being filled out. Also the sheets in the different departments are usually not all the same size, and this makes it difficult to file a complete record of the performance of each day in the same volume. Instead of having one ledger of your records, you have a number of sections of this ledger.

The following scheme of records seems to surmount the difficulties of the preceding one. Instead of having one large sheet for all the readings, have a pad of small sheets placed at each point where a reading is to be taken. These pads could be printed to show the instrument whose record they gave. Then the operator would have to go to the instrument in order to put down the reading. At the end of his shift each operator could collect all his records, and turn them in as he went off duty. A better system might be to have the relieving operator enter the last reading and turn them in within a certain time after he came on shift. This would be evidence that he had visited these parts of the plant and noted conditions, as all operators are supposed to do immediately after coming on shift.

It will also be noted that the records of recording

instruments fit in very well in this scheme, as they can be handled just the same as these small sheets. Coal-weight tickets could be turned in by each operator and twenty-four hour recorder charts could be turned in by one operator.

The small record sheets just mentioned correspond to the daybook in a business establishment. The second part of this system corresponds to the ledger. It is a composite record and may be kept by the chief engineer or by a clerk designated for that duty. It is thus seen that the requirement for extreme simplicity in this part is not so burdensome as to impose serious restrictions on dependability and completeness. This record could be a standard form which could be purchased in several different types according to the size of plant and type of equipment. Thus for plants of 1,500 kw. and under, we might have one form for turbine plants, another for reciprocating-engine plants and another for Diesel-engine plants. For plants of 1,500 kw. to 7,500 kw. we might have the same series of forms, and so on for still larger plants. Any one plant could then purchase standard record sheets that would best suit its purpose. Accompanying this article is a sample of such a form for the boiler room of a 1,500-kw. plant.

BOILER ROOM OPERATING LOG

POWER PLANT DATE:

COAL

Shift	Total Amt. Fired, lb. No.1	No.2	No.3	No.4	Total Amount per Shift	Total for 24 Hrs.	Remarks as to Irregularities in Quantity or Quality
1st. 6 A.M.-2 P.M.							
2nd. 2 P.M.-10 P.M.							
3rd. 10 P.M.-6 A.M.							

Analysis from Laboratory: Moist ____ V.C. ____ F.C. ____ Ash ____ Sulphur ____

COAL RECEIVED FROM MINES		
Car No. & Initials	Contents-Tons	Remarks as to Quality

ASH

Shift	Weight of Ash No.1	No.2	No.3	No.4	Total Weight of Ash	Remarks as to appearance:-Large or small Clinkers; excess of Coke, etc.
1st.					lb.	
2nd.					lb.	
3rd.					lb.	

FEED WATER

Total Amount per Shift	Total for 24 Hrs.	TEMPERATURE							
lb.		6A.M.	7	8	9	10	11	12	1P.M.
lb.		2P.M.	3	4	5	6	7	8	9
lb.	lb.	10P.M.	11	12	1A.M.	2	3	4	5

COMBUSTION

Time		6A.M.	7	8	9	10	11	12	1P.M.	2	3	4	5	6	7	8	9	10	11	12	1A.M.	2	3	4	5
Temp. in Breeching °F.	Boiler No.1																								
	2																								
	3																								
	4																								
% CO_2	Boiler No.1																								
	2																								
	3																								
	4																								
Draft in Furnace In. Water	Boiler No.1																								
	2																								
	3																								
	4																								
Air Pressure Main Tunnel	In. Water																								

Flue Gas Analysis		8 A.M. % CO_2	% CO	% O_2	% N_2	4 P.M. % CO_2	% CO	% O_2	% N_2	12 P.M. % CO_2	% CO	% O_2	% N_2
	Boiler No.1												
	2												
	3												
	4												

STEAM

Time		6A.M.	7	8	9	10	11	12	1P.M.	2	3	4	5	6	7	8	9	10	11	12	1A.M.	2	3	4	5
Master Pressure Gage																									
Total Flow Since 6A.M. lb.	No.1																								
	2																								
	3																								
	4																								
Quality or Temperature	No.1																								
	2																								
	3																								
	4																								

WATER SOFTENER

	Analysis of Treated Water 6A.M.	9A.M.	12 Noon	3P.M.	6P.M.	9P.M	12 Night	3A.M.
H								
C								

Remarks:-

Analysis of Boiler Water at 6A.M. Boiler	H	C	Total Solids	Days in Service	Blow Down Frequency	Length
No.1						
2						
3						
4						

GENERAL

UNITS STARTED UP Name	Time	UNITS STOPPED Name	Time	BOILERS BANKED Boiler No.	Time	FIRES BROKEN Boiler No.	Time

UNITS INSPECTED OR REPAIRED	SUPPLIES DRAWN OUT OF STORE	ACCIDENTS

Proposed standard boiler-room operating log for plants under 1,500 kw.

BOILER INSPECTION REPORT

(*Name of plant*) Power Plant Date.....
Date boiler was taken off line.....

SETTING

Outside walls.....
Furnace lining.....
Arch.....
Bridge wall.....
Baffles.....
Inspection doors.....
Miscellaneous.....

STOKER

Engine or driving mechanism.....
Coal spout.....
Hopper.....
Coal feeding mechanism.....
Grates.....
Dumps.....
Clinker grinders.....
Ash pit or hopper.....
Miscellaneous.....

BOILER

Internal condition of drums.....
Internal condition of tubes.....
External condition of drums and tubes.....
Dry pipe and steam connection.....
Water pan.....
Tested at what hydrostatic pressure.....
Leaky tubes to be renewed.....
Leaky tubes to be rolled.....
Miscellaneous.....

SUPERHEATER

Internal condition.....
External condition.....
Leaky elements to be rolled or renewed.....
Miscellaneous.....

AUXILIARIES

Safety valves (also give pressure for which set).....
Feed water line.....
Water-level controlling mechanism.....
Water column.....
Pressure gage.....
Blow-off line and valves.....

REMARKS: (give here general instructions for getting boiler ready to go on line again).....

I certify that I have made, or caused to be made, the inspection covered by this report.

Signed .....

The sheet could be made larger and the turbine- or engine-room record be put on the same sheet. It would follow the same general construction.

The readings on the operators' record sheets turned in each day would be transferred to this large sheet by the person designated for that duty. Records from recording instruments would be put on this sheet also, the value entered for any particular reading being the average since the time of the preceding entry. It will be noticed that space is also provided for entry of records of a special nature, such as the operation of the water softener, accidents, inspections and repairs made, etc. Such items as are not necessary need not be recorded without running into the objection one meets if blank spaces are left on the operators' sheets. This sheet then becomes a complete record of the plant operation for that day and will furnish all necessary information should one wish to review that operation a month or a year hence. These sheets can be kept in a file. Moreover, weekly, monthly or yearly records can be kept at the proper place in the same file.

In order to interpret these records quickly a set of curves or charts can be prepared. By the use of these charts the performance of any unit in the plant or the plant as a whole may be quickly obtained. These results, when compared to a plant "bogey," are what determines whether or not some unit is in need of repairs or cleaning, or whether operating conditions are being maintained as they should be. It is also a good idea to stimulate interest in the operating force by keeping them informed as to the most pertinent results. A blackboard placed at some readily accessible point in the plant is an excellent means of keeping the results up to date.

The system outlined will cover in a fairly thorough way the operation of the plant. But inspection and repairs are just as important, and provision must be made for records of these. Certain pieces of apparatus can be placed on a regular inspection schedule, while others have to be inspected as the necessity arises, as shown by operating results. The best way to handle this is to have a standard form for each piece of apparatus. Standard forms could be provided for boilers and superheaters, turbine pumps, reciprocating pumps, condensers, motors, etc. A sample form for a boiler and superheater is attached. All these forms should be of the same size in order to facilitate filing.

The proper form would be filled out by the man making the inspection and would then be filed in the inspection and repair file. Whenever any repairs were made, a report of these would be filled out by the foreman making repairs and filed with the inspection report calling for these repairs. As mentioned before, notation of these inspections and repairs would be made in the proper space on the operating log, as this is the main record of the plant.

It is felt that this system could be made complete enough to cover all needs and that it is flexible enough to suit the needs of any plant. Its widespread adoption would result in the keeping of sufficient records to supply intelligent information of operating results and would also make it more easy to compare the performance of different plants. On account of quantity production the standard forms required could be obtained at less expense than a separate set could be made up for each plant.

Increasing Boiler Capacity and Efficiency in Same Floor Space

BY CHARLES J. HERBECK
Chief Engineer, Iowa Railway and Light Company

IN THE boiler plant of the Iowa Railway & Light Co., of Cedar Rapids, additional capacity was needed. Owing to lack of space in the present building an idea was conceived whereby the capacity and the efficiency of the boilers installed could be increased at relatively small expense. Economizers were considered as a means of increasing capacity and economy, but the cost was prohibitive on account of the design of the building.

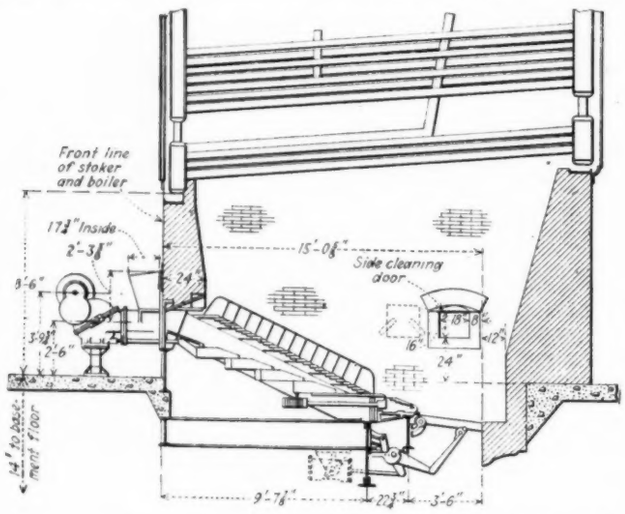


Fig. 1—New furnace arrangement showing drop-leg addition to boiler and the new baffling

In the plant there are sixteen water-tube boilers, eight of them having 6,280 sq.ft. of heating surface each, equipped with underfeed stokers. It became necessary to reset two of the boilers, and at the same time it was decided to try out the proposed plan for increasing the capacity and efficiency. The scheme was to turn the boilers around, add three rows of tubes, similar to a drop bank boiler, change the baffling and install larger stokers, inasmuch as the old stokers were worn out.

To accommodate the additional heating surface, two short headers were made up and connected to the old tube headers by fifteen 4-in. nipples which serve as circulating tubes. Originally, the boilers were vertically baffled for three passes. The rearrangement consists of a horizontal baffle on top of the third row of tubes for practically two-thirds of their length and then two vertical baffles dividing the original heating surface into three vertical passes. To accommodate this setting, it was necessary to install a new breaching. Fig. 1 shows the rearrangement of stoker and furnace.

It first appeared that the turning would be a difficult task, but in the end it proved simple. The boiler was let down to the boiler-room floor on cribbing, 5-in. rollers were placed under each end and two hoisting crabs were used in pulling it around. It was found that by hanging a plumb bob exactly in the center of the boiler, both ways, and having all rollers point toward this plumb bob, the boiler turned on a perfect circle and did not require any more room than the space in which it was set. The boiler was turned and landed in almost the exact location in which it was originally set. It required five hours to turn one boiler from the time it was let down onto the rollers. Fig. 2 shows one of the boilers on rollers as it is being turned.

More relieving capacity per boiler was needed owing to the additional heating surface and the higher operating capacity. It was necessary also to rearrange the foundation slightly, as the boiler supports were located differently from the original and new brackets had to be placed on the tube headers for the supports. Fig. 3 shows the method of connecting the added bank to the original boiler.

With the new arrangement the furnace volume has been doubled. To secure the desired volume, it was necessary to drop the rear end of the stoker 17 in. below the boiler-room floor. This proved to be of considerable advantage during dumping periods, as it is more convenient for the operator to see the dump grates,

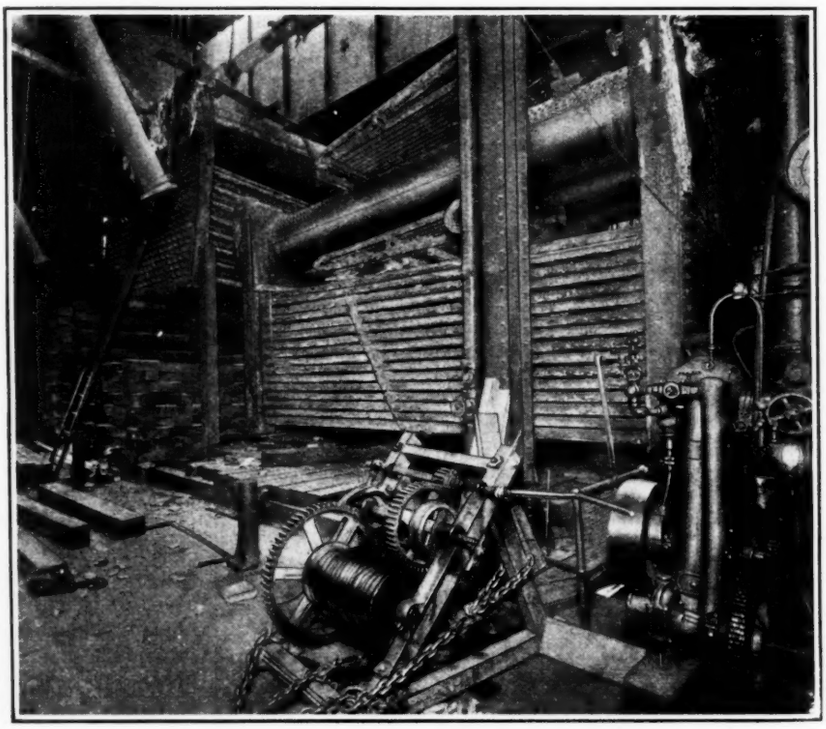


Fig. 2—Turning one of the boilers on rollers

and he can observe conditions from the firedoor with less effort than on the old setting.

The two boilers are now fired by 7-retort, 29-tuyere underfeed stokers with individual motor drive through silent chains. The motors are of the wound-rotor type with the controller mounted on a panel directly in front of each boiler. The fans also are equipped with wound-rotor motors and the controllers are mounted on the same panel. This makes a flexible arrangement, as the

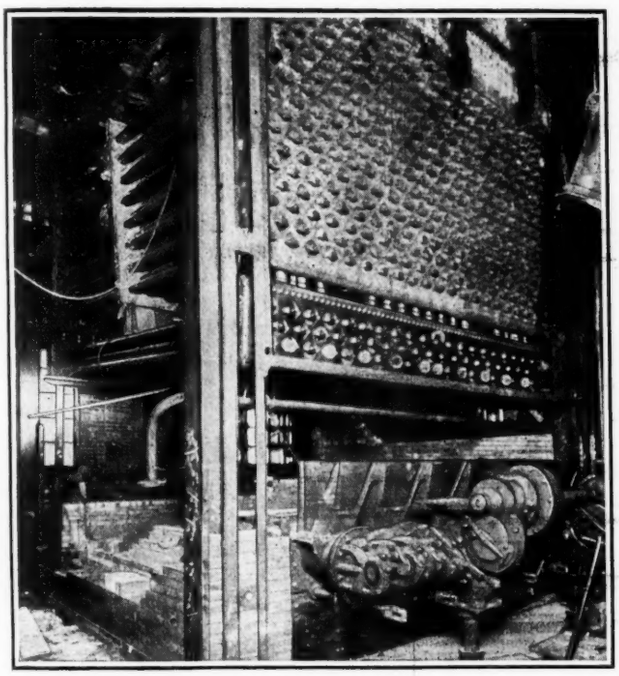


Fig. 3—Showing method of connecting added bank to original boiler

operator has the control equipment and the instruments as well, all on the same panel directly in front of the boiler, so that he can tell at a glance the required stoker and fan speeds and make the necessary adjustments. Regulators have been provided for controlling automatically the air to the furnace. The operator simply sets the controller on a point that will give him the amount of air for the rating at which he is to operate the boiler.

Available capacity on these boilers has been increased nominally 55 per cent, and it is possible to operate up to 280 per cent of rating for short periods. The modified units have been running at considerably better efficiency than the original boilers. For the last six months they have averaged 77.74 per cent efficiency. This is accounted for by better heat absorption and less combustible in the ash. Another advantage is that the boilers respond more readily to changes in the steam requirements, making it practical to cut down on the number of banked boilers, an item of importance.

The striking feature of this work was the low cost for the capacity gained as compared to a new installation or an addition to the boiler room. The total project, including stokers, stoker motors and fan motors, all control equipment and other necessary material, amounted to $39.45 per 10 sq.ft. of heating surface gained. As a result it has been decided to carry out the same plan on the other six boilers equipped with underfeed stokers.

Heat Accumulators

By Prof. A. G. Christie

STEAM TURBINES can utilize vacuum to better advantage than steam engines. This fact was noted early in their development, and as a result low-pressure turbines were installed in many plants to utilize the exhaust steam of non-condensing reciprocating engines. In certain plants such as rolling mills, etc., it was not possible to furnish a continuous supply of exhaust steam to the turbines, which invariably were connected to turbo-alternators and supplied electric power. At times there would be an excess of exhaust steam from the engines and at other times there would be a deficiency.

Professor Rateau designed his accumulator to care for this condition. This accumulator generally consisted of a large steel cylinder placed horizontally and almost filled with water through which the exhaust steam bubbled. When there was an excess of exhaust steam, the back pressure on the engine was allowed to rise. The increased heat of liquid corresponding to the higher pressure was furnished to the large mass of water by condensation of the excess portion of the exhaust steam. Heat was thus stored in the water of the accumulator. This heat was released by a lowering of the pressure when there was a deficiency of exhaust from the engine. Boiling took place when the pressure fell, and thus the necessary steam was furnished at the low-pressure turbine to maintain the load. The pressure limits in the Rateau accumulator were not great, seldom exceeding five pounds above and below atmospheric pressure.

A new form of heat storage has been used in Europe. This is known as the Ruth's[1] accumulator. It functions somewhat like the Rateau but over higher and wider ranges of pressure. It has been used largely in connection with boiler plants serving industrial processes where steam demands at different pressures fluctuate widely throughout the day. The usual plan is to provide valves so that the accumulator can be furnished with steam at an increasing pressure, in some cases up to full boiler pressure, during times of light load on the boilers. Then when a peak demand comes for process steam at a pressure much below boiler pressure, a portion or all of this can be furnished by drawing steam by ebullition from the accumulator.

There are possibilities of applying this device to a certain extent in electric generating stations. Suppose in a small plant there is insufficient exhaust steam to maintain the boiler feed at its maximum temperature at times of peak loads. An accumulator of this type could be used to furnish this deficiency. In some large central stations bled steam is used for station heating and for evaporating makeup water. With an accumulator charged at light loads, these heating and evaporating loads could be taken off the turbine and boilers at the time of the peak, if this is of short duration, and some saving in boiler capacity thereby effected. A plant furnishing heating service only would seem to offer possibilities for the use of accumulators. Usually, there is a large steam demand when buildings are turned on in the early morning while the night load is small. If the accumulators were charged at night, it would improve the night load. Their use on the morning peak would lessen the overloading of the boilers and thus tend toward better station performance.

[1]For complete description see *Power*, Aug. 28, 1923.

Application of Static Condensers to Power-Factor Correction

By R. E. MARBURY
Supply Engineering Department, Westinghouse Electric & Manufacturing Company

What Power Factor Is—Conditions on the Circuit That Cause Low Power Factors—Effects of Low Power Factor—Construction of Static Condensers—Condenser Units Available for Power-Factor Correction—Application Problem Worked Out

POWER-FACTOR correction is receiving more and more attention as time goes on and has become a foremost problem in the distribution and utilization of alternating current. The entire system performance, from the generators to the power-consuming devices is largely dependent on load power factors. The term power factor describes a condition existing in a circuit. It is an indication of the ratio between useful and wattless current. In an alternating-current system the generator's lines and distribution equipment serve only to convert the prime-mover energy into electrical energy and deliver it to the point where it is to

Fig. 1—Condenser unit before assembly in metal case

be turned again into mechanical energy to do work. The cost of handling and delivering this useful energy is dependent a great deal on power factor.

Electrical apparatus may be divided into two distinct classes—those that merely dissipate energy as long as potential is applied, and those that not only dissipate, but actually store energy. When the potential is removed in the first case all action ceases. In the latter case the dissipation of energy continues for a time and the stored energy tends to flow back into the source or to relieve itself in some way, if possible. The second class may be subdivided with respect to the manner in which the energy is stored.

When a current of electricity is passed through a coil of wire, there is established a magnetic field. This magnetic field represents stored energy due to electricity in motion and corresponds to kinetic energy. It is generally termed electromagnetic energy. On the other hand, if a mass of insulation is subjected to an electrical pressure, an electrostatic field is produced within the material, and electrostatic energy is stored. This corresponds to potential energy, or energy of position of electricity at rest.

These two types of stored energy differ not only with respect to the material in which they can exist, but with the manner in which the energy is stored.

If an inductance, a coil wound on an iron core, is connected to a direct-current circuit, the current starts at zero and gradually rises until a final value is reached. This final and maximum value is dependent on the resistance of the wire. If, on the other hand, a mass of insulation distributed between metal plates of an appreciable area is connected to a source of direct-current, the current starts at a value limited only by the resistance of the wire and plates and falls to a final and very small value depending on the leakage losses in the insulation.

All alternating-current circuits contain magnetic and electrostatic energy. The connecting wires have a certain amount of inductance. The fields of transformers, generators and motors require magnetic energy. Electrostatic energy in small amounts is stored in the air and solid insulations subjected to voltages.

In an alternating-current circuit the voltage varies from zero to a maximum value in both positive and negative directions by virtue of the manner in which the generator field is cut by the rotation of the armature conductors. If a device of the first class is connected to an alternating-current line, the current flowing will always be equal to the voltage divided by the resistance, and the power consumed will be the product of the two. If either of the last two subdivisions is considered, the instantaneous power in the circuit will be equal to the product of the instantaneous voltage and current but this will not represent the power being consumed. Part of the time, energy will be flowing from the source into the energy-storage device, and the remaining time energy will be returned to the line. The energy actually being consumed is the energy coming from the source minus the energy returned. A theoretical case could be considered where all the energy would be returned to the source. This, of course, requires an ideal condition of no losses in any part of the circuit.

With an alternating voltage applied to a circuit capable of storing energy, the most efficient condition will be when the natural period of the circuit is the same as the period of the applied voltage. This requires that there be an equal amount of electromagnetic and electrostatic energy in all parts of the circuit. In this way the line is not required to contend with this stored energy, and the whole load falls in the first class, described in the foregoing, where no energy is stored as far as the generators and lines are concerned.

When a condition exists where there is no stored energy in any part of the circuit, or where the stored energy of one type is exactly balanced by that of the other, we have unity, or 100 per cent power factor. Where the stored energy is all of the one type or where there is an excess of one kind, the energy handled by the line is greater than the energy consumed and the power factor is less than 100 per cent. When the flow of energy back into the line precedes the voltage, we say the power factor is leading and when the opposite, it is lagging. In a single-phase circuit the

$$\text{Power factor} = \frac{\text{True power consumed}}{\text{Volts} \times \text{amperes}}$$

or;

$$\text{Power consumed} = \text{Volts} \times \text{amperes} \times \text{power factor}$$

The energy that is handled by the circuit but is not consumed, is generally called the wattless or reactive component.

The cost of electric energy at the consumer's plant may be considered as made up of three general items: Interest on investment, cost of system operation, and cost of fuel. When water power is considered, the latter item disappears but the first is generally increased. The investment may be divided into prime movers, generators, transmission and distribution equipment. The size of generators and, therefore, the cost depend not on the energy consumed, but the energy handled. The same is true of the transformers. The cost of line depends on the current to be handled. Four times as much copper is required to transmit a given load at 50 per cent power factor as at 100 per cent power factor with the same line losses. This is due to the fact that the line current increases directly as the power factor decreases and the line losses vary as the square of the current. It requires 25 per cent more generator capacity to generate the same amount of power at 80 per cent power factor than it does at 100 per cent.

As previously shown, the investment in generators, transmission and distribution equipment per kilowatt of power increases rapidly as the over-all power factor of the system becomes lower. Progressive power companies are endeavoring to reduce the amount of excess investment due to low power factor and to distribute the investment charge on the equipment handling the remainder with respect to the operating power factor at the various consumers' plants. This is being accomplished through various rate systems, including power-factor clauses. To describe even a few of the rates in effect would require considerable space. The net result is that if power factor is improved near the load, both the consumer and power company profit.

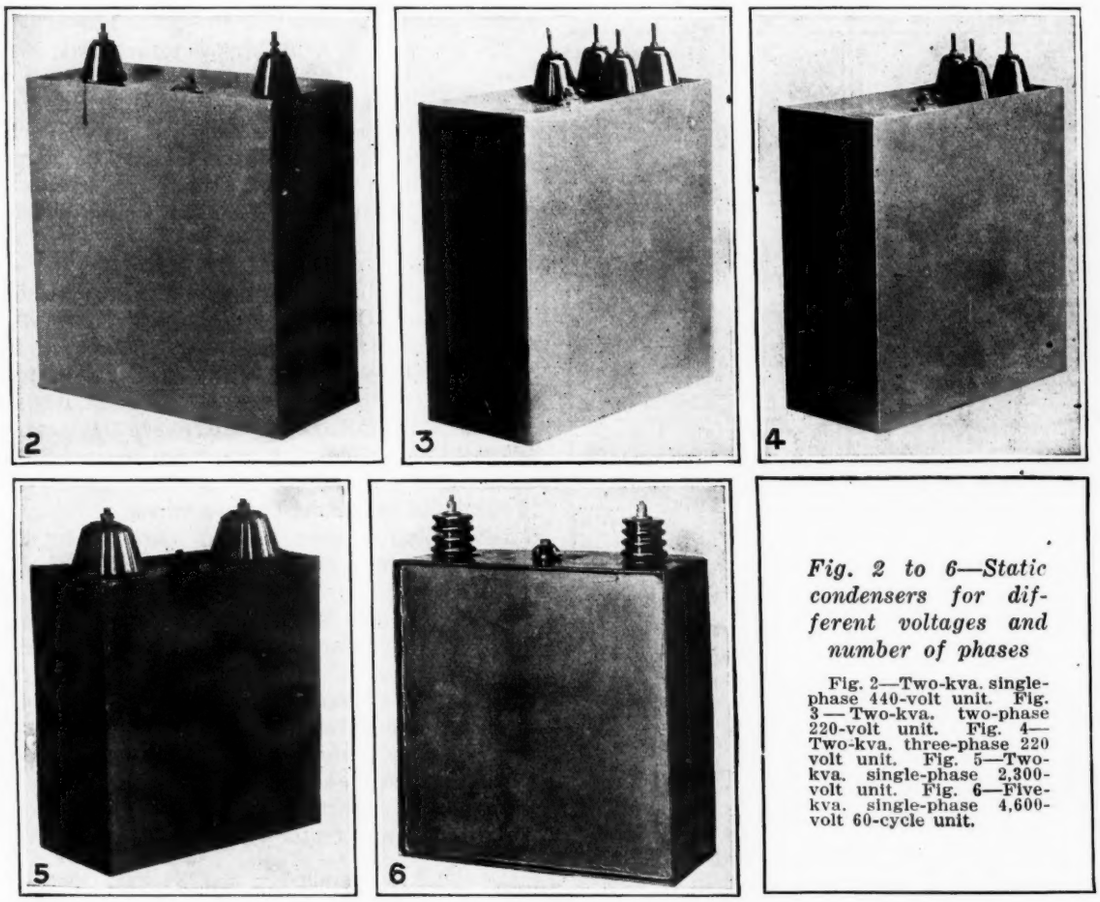


Fig. 2 to 6—Static condensers for different voltages and number of phases

Fig. 2—Two-kva. single-phase 440-volt unit. Fig. 3—Two-kva. two-phase 220-volt unit. Fig. 4—Two-kva. three-phase 220 volt unit. Fig. 5—Two-kva. single-phase 2,300-volt unit. Fig. 6—Five-kva. single-phase 4,600-volt 60-cycle unit.

Power factor may be improved by redistribution of motors so that they are better proportioned to the load requirements and, therefore, run more nearly full load. Synchronous motors may be used on loads where they are adaptable. Where large amounts of power are involved, synchronous condensers may be used to advantage.

It is the object of this article to describe only static condensers as a means of correcting power factor and to point out the recent depelopments that have broadened the field of this class of corrective equipment.

When a mass of insulation is subjected to a potential difference as previously described, energy is stored. Materials differ in their ability to store electrostatic energy, everything else being equal. Air is chosen as a

standard and other materials are rated in specific inductive capacity according to the increase or decrease in energy-storage capacity with respect to air, as 1 for air, 6 for mica, 3½ for oil-insulated paper, etc.

In order to apply potential to insulation conveniently, it is assembled in the form of sheets, between conducting plates, generally tin foil. The combined thickness of each insulating unit is dependent on the voltage applied. The thickness of the sheets making up the layer is a matter of cost quality and varies with different designs.

Numerous layers of insulation are stacked between metal plates. Alternate plates extend in opposite direction and are soldered into a solid terminal, Fig. 1. These sections are assembled in metal cases, vacuum treated and filled with oil. The combination of oil and properly selected paper makes a very commercial and

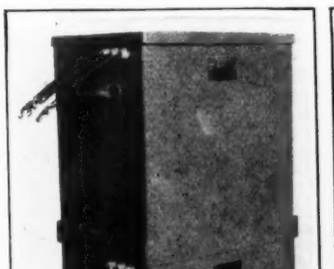


Fig. 7—Three-phase 12-kva. 220-volt 460-cycle static-condenser unit

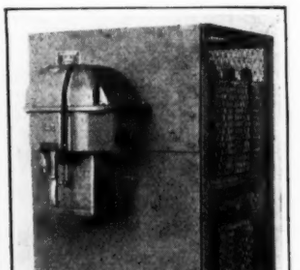


Fig. 8—Three-phase 36-kva. 2,300-volt 60-cycle static-condenser unit

extremely efficient insulation. Of the energy stored 99½ per cent is returned to the system. In other words, the losses are about ½ per cent of the operating kilovolt-ampere capacity.

The first static condensers were built for 1,200 to 2,300 volts, 60-cycles. When it was desired to make correction of power factor on voltages such as 220 or 440 or 4,600, transformers were used to step the voltage up or down as the case might be. The use of the transformers was undesirable on the small sizes since it added considerable to the first cost and gave a loss of about 35 watts per kilovolt-ampere instead of 5 watts.

The demand for condensers for direct connection on low voltages grew out of a desire to eliminate the transformers on the smaller sizes and also eliminate a great deal of the local line drop by connecting the condenser direct to the motor terminals. It was desirable also to make correction on small polyphase motors where the total kilovolt-ampere capacity required was only two in some cases.

Condenser units of 2-kva. capacity for one, two and three phases on 220-, 440- or 550-volt circuits are shown in Figs. 2 to 4. In Figs. 5 and 6 are shown single-phase condensers for 2,300 and 4,600 volts, the latter being a recent addition to the line of static condensers available.

Cabinets are made up to hold one or two of the units shown in Figs. 2 to 4, making 2- or 4-kva. capacity in a single unit. The 2-kva. assembly is generally adaptable to motors from 3- to 10-hp. rating and the 4-kva. from 10- to 25-hp. motors. Three units are assembled in cabinets making 6-kva. outfits for motors from 25 to 50 hp. The 6-kva. outfits are designed to fit one above another, making 6-, 12- or 18-kva. units, as in Fig. 7. The 2,300- and 4,000-, 4,600- or 5,000-volt units are assembled in the usual frames as shown in Fig. 8. These are also made up for outdoor service. Using these assemblies, correction may be made on each motor, on the ends of local feeders or on either side of the service transformers.

Generally, it is found more economical to correct the power factor of the plant as a whole, due to the diversity factor. In other words, there are generally less motors running at all times than actually installed. This is especially true if power factor alone is considered. Many cases have been found where the high wattless current caused line drop at the motor and impaired the motor performance, particularly during acceleration. In many such cases static condensers have been found to eliminate a great deal of this line drop and cause the motor to have the desired snappy action.

Choosing Corrective Equipment

In choosing corrective equipment, a careful analysis is justified. Often it is found that the addition of proper corrective equipment not only corrects the power factor at the service switch, but improves motor performance. In some cases the latter in itself justifies the installation of the corrective apparatus. The kilovolt-ampere capacity of condensers required may be determined as follows:

First, the load must be determined.

Divide the present load in kilowatts by the corresponding power factor to determine the kilovolt-amperes.

Determine the kilovolt-amperes at the new power factor by dividing the kilowatts by the new power factor.

Determine the reactive or wattless component in each case, and the difference will be the reactive kilovolt-amperes in condenser capacity.

Present load equals 200 kw. at 60 per cent power factor.

Desired power factor equals 90 per cent.

Present kva. equals $\frac{200}{0.60} = 334$ kva.

Present reactive kva. equals $\sqrt{334^2 - 200^2} = 268$.

Kva. at new power factor equals $\frac{200}{0.90} = 222$.

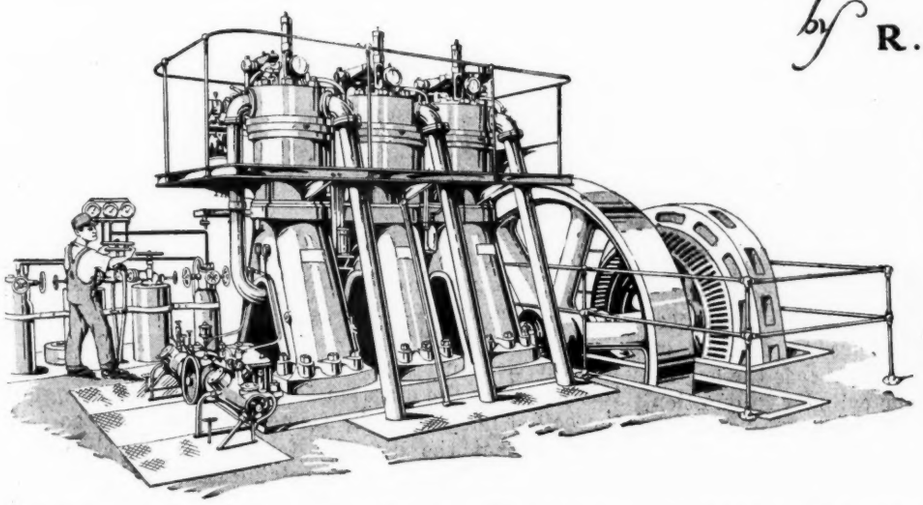
Reactive kva. equals $\sqrt{222^2 - 200^2} = 96.5$.

Capacity of condenser to make correction equals $268 - 96.5 = 171.5$ kva.

The earlier designs of static condensers were made for one voltage only. Correction on other voltages involved special problems of connections or the use of transformers. At present it is possible to provide correction on practically all standard voltages between 220 and 5,000 without transformers, which greatly broadens the field of condensers for power-factor corrections. In order to derive the maximum net saving from correction, it is necessary to select the proper ratings and correct at the proper points on the power system. The financial saving involved justifies a careful study in each case.

OPERATION OF DIESEL ENGINES

by R. Hildebrand *



Some Facts on Inlet and Exhaust Valves

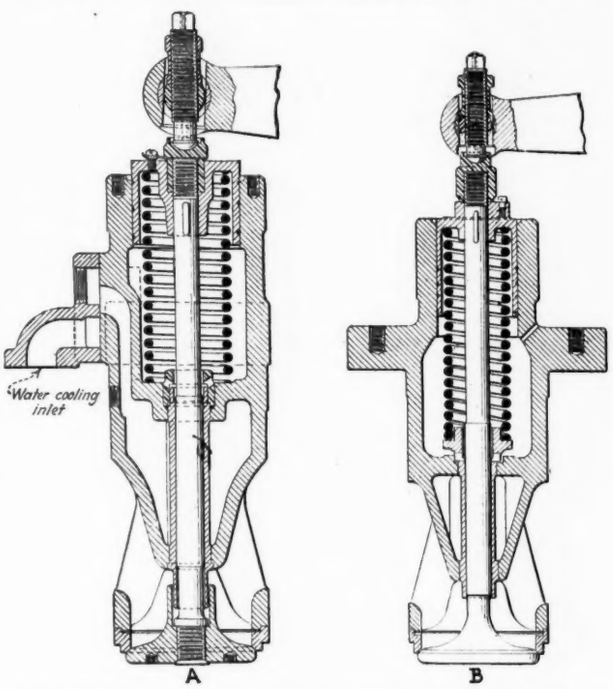
AN EXHAUST and an inlet valve for a Diesel engine are shown at *A* and *B*, respectively. Notice that both valves are housed in cages having removable seats. The inlet valve and its stem are forged integral of open-hearth steel, while the exhaust valve has a cast-iron head securely fastened to a steel stem. The reason the exhaust valve is made of cast iron and not of open-hearth steel is that the former material warps, burns and pits less than the latter when subjected to heat. Thus cast-iron exhaust valves keep tight better than steel ones. Note further that the exhaust-valve stem is guided in a water-cooled bushing. The bushing is provided with a skirt reaching into an extension of the valve head. The object of the water-cooled exhaust-valve bushing is to prevent the lubricant on the valve stem from carbonizing and gumming, which so often causes the valve to stick open. The skirt and the housing protect the exhaust-valve stem from overheating and pitting. The inlet as well as the exhaust valves of most engines are controlled by cam-operated rocker arms carrying swivels at their ends with adjustment screws and locknuts. These screws are drilled through their entire length to enable oil to lubricate the ball and socket.

The inlet valves, which are continuously cooled by the intake air, should require but little attention, while the exhaust valves, which attain high temperatures, may cause trouble if they do not receive proper attention.

In order to obtain good results with exhaust valves, their temperatures must be kept as low as possible. If the combustion is sufficiently rapid to be completed during the early part of the working stroke, the gases inside of the working cylinder will expand down near to atmospheric pressure and the exhaust-gas temperature will be low. Low exhaust temperatures in connection with effective water cooling and proper lubrication of the exhaust valves are requirements that must be fulfilled if good service is to be obtained. If the combustion is bad, extending nearly over the entire power stroke the exhaust-gas temperature will be high, and even flames may pass out through the valves. If, in addition to this, the water jackets of the exhaust valves are thickly coated with scale, preventing the valve from being cooled, trouble will follow.

Leakage of an inlet valve can easily be detected by a hissing noise in the intake muffler, and if the hand is brought near the inlet valve, the hot gases escaping through the valve can be felt.

The heat and the pressure inside the cylinder may cause the valve head, the valve cage, its seat, and even the entire cylinder head, to warp out of true. To remedy this, the loose valve seat should be ground occasionally. If this is done, the valves and the gaskets between the valve seats and the cylinder head will hold tight. Copper asbestos gaskets are best for the inlet and exhaust valves, although some manufacturers use only beveled seats between the cages and the cylinder heads. In this case the tightness depends entirely on whether or not the seats are carefully ground. By try-



Inlet and exhaust valves of a four-stroke-cycle engine

* Chief engineer, Diesel Division, Fulton Iron Works Co.

ing to remedy the blowing of the gaskets or beveled valve cage seats by over-tightening the nuts that hold the valve in place conditions are made worse, and the valve and even the cylinder head may crack. As the exhaust valve is always subjected to much more heat than the inlet valve, naturally the former wears out more rapidly. In addition, carbon may come between the exhaust valve and its seat, causing "pitting" and leakage.

A leaky valve should be taken apart and ground to its seat with a grinding compound. A badly pitted valve should be smoothed over with a fine file before grinding, and if the condition is extremely bad, the valve and seat should be trued up in a lathe.

If an inlet or exhaust valve or their gaskets should blow, or if one of these valves does not properly close, owing to sticking or insufficient cam-roller clearance, the affected cylinder will fail to fire on account of having insufficient compression. In this case the engine may not pull its rated load and the cylinder in question will have a smoky exhaust of a bluish color.

The valve may stick if its stem fits too snugly in the guide bushing, not having sufficient clearance for expansion. An exhaust valve has a greater tendency to stick than an inlet valve, because of the heat. The gumming up of the exhaust valve is caused either by bad combustion or by improper lubrication of the valve stem. Since only a few drops of lubricating oil per hour are needed to lubricate the valve-spring caps, generally sufficient oil drips down from the swivel joints above the stems. In the case of the exhaust valves any excessive dripping is harmful, for it will work itself down between the spring cap and valve cage and find its way to the valve-stem bushing. Lubricating oil entering the valve-stem bushing will cause a carbon deposit on the stems, as the temperature at the lower end of these bushings is so high that the lubricating oil will decompose or "crack." To counteract this sticking apply a few drops of kerosene about every hour or two through a hole drilled in the valve cage.

If an inlet or exhaust valve sticks and remains open, the piston may strike it and bend the valve stem or cause other damage to the valve. A valve will not close properly if its spring is broken, in which case the valve makes a heavy flapping noise. This flapping is also noticeable in case the valve sticks. A spring that has fatigued and lost its original strength should also be replaced by a new one even if it is not broken. Too weak a spring may cause the exhaust valve to be sucked open during the suction stroke of the engine.

Obstructions in Inlet and Exhaust Passages

There is a possibility that the inlet and exhaust passages may become obstructed, in which case the engine fails to carry its rated load and develops a smoky exhaust. If an obstruction in the intake or exhaust passages is suspected, an indicator diagram should be taken with a light spring, using a full-sized piston in the indicator. If the suction or exhaust resistance on the diagram is appreciably lower or higher than 3 to 4 lb. per sq.in. an investigation should be made relative to the cause of the resistance.

If the indicator diagram shows too low a suction-air pressure, the intake muffler of inlet valve should be cleaned, as in time it will clog up and the amount of air sucked into the cylinder will diminish.

The indicator card will show by a high exhaust pressure line, that the passages of the exhaust valves and pipes are obstructed.

Nomogram for Mean Effective Pressure

By L. Morgan Porter*

THE accompanying chart, known technically as a nomogram, is a graphical means for finding the mean effective pressure of a reciprocating steam engine given by the formula,

$$m.e.p. = \left[\frac{1 + \log_e R}{R}\right] P_1 - P_2$$

where *m.e.p.* equals mean effective pressure, lb. per sq.in.; P_1 equals steam pressure, lb. per sq.in. abs.; P_2 equals back pressure, lb. per sq.in. abs.; R equals reciprocal of the cutoff ratio.

This formula alone gives the ideal m.e.p. for a card without clearance or compression, but by multiplying this result by the diagram factor for the given engine, the actual m.e.p. may be found. The chart is so constructed that the diagram factor can be taken into account graphically, thereby giving the actual m.e.p. for the engine. The accuracy of the results depends on the accuracy of the value assumed for the diagram factor. A table of diagram factors which commonly apply will be found in Kent's "Mechanical Engineers' Handbook," tenth edition, page 1,045.

The following example illustrates the use of the chart: Assume an engine taking steam at 180 lb. abs., back pressure equivalent to a vacuum of 27 in., a cutoff ratio reciprocal of 4[1], and a diagram factor of 80 per cent. It is desired to find the actual m.e.p.

By means of a straight-edge or string connect up point marked 180 on scale P_1 and point 4 on scale R. Extend this line to the scale marked "Ideal m.e.p. $+ P_2$." This operation is shown on the chart by a dotted line. The value found on this scale is the sum of the ideal m.e.p. and the back pressure.

In order to take into account the back pressure and the diagram factor, the scales at the left side of the chart have been added. Continuing from the point just found and proceeding parallel to the inclined lines till we come to 27 in. of vacuum on the vertical lines, shown at point A, we have graphically subtracted the back pressure in terms of inches of vacuum, thereby giving us the ideal m.e.p.

It now remains only to multiply the ideal m.e.p. by the diagram factor. From the point A just found, proceed parallel to the horizontal lines to the intersection with the oblique line marked 80 on the diagram-factor scale. Vertically above this point will be found the value for the actual m.e.p. This is shown at point D and is equal to 85 lb. per square inch.

The chart may also be used when running noncondensing and when exhausting at low gage pressures such as might obtain when exhausting into heating systems. An example is worked out on the chart when exhausting to atmosphere, the other data remaining unchanged. An actual m.e.p. of 73 lb. is obtained (at C).

It should be noted that the scale for back pressures is graduated in inches of mercury vacuum below atmospheric pressure.

The design of this chart is based on principles covered in the book "Design of Diagrams for Engineering Formulas" by Hewes and Seward.

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*Assistant in mechanical engineering, Sheffield Scientific School, Yale University.

[1]That is, the cutoff is at one-quarter stroke.

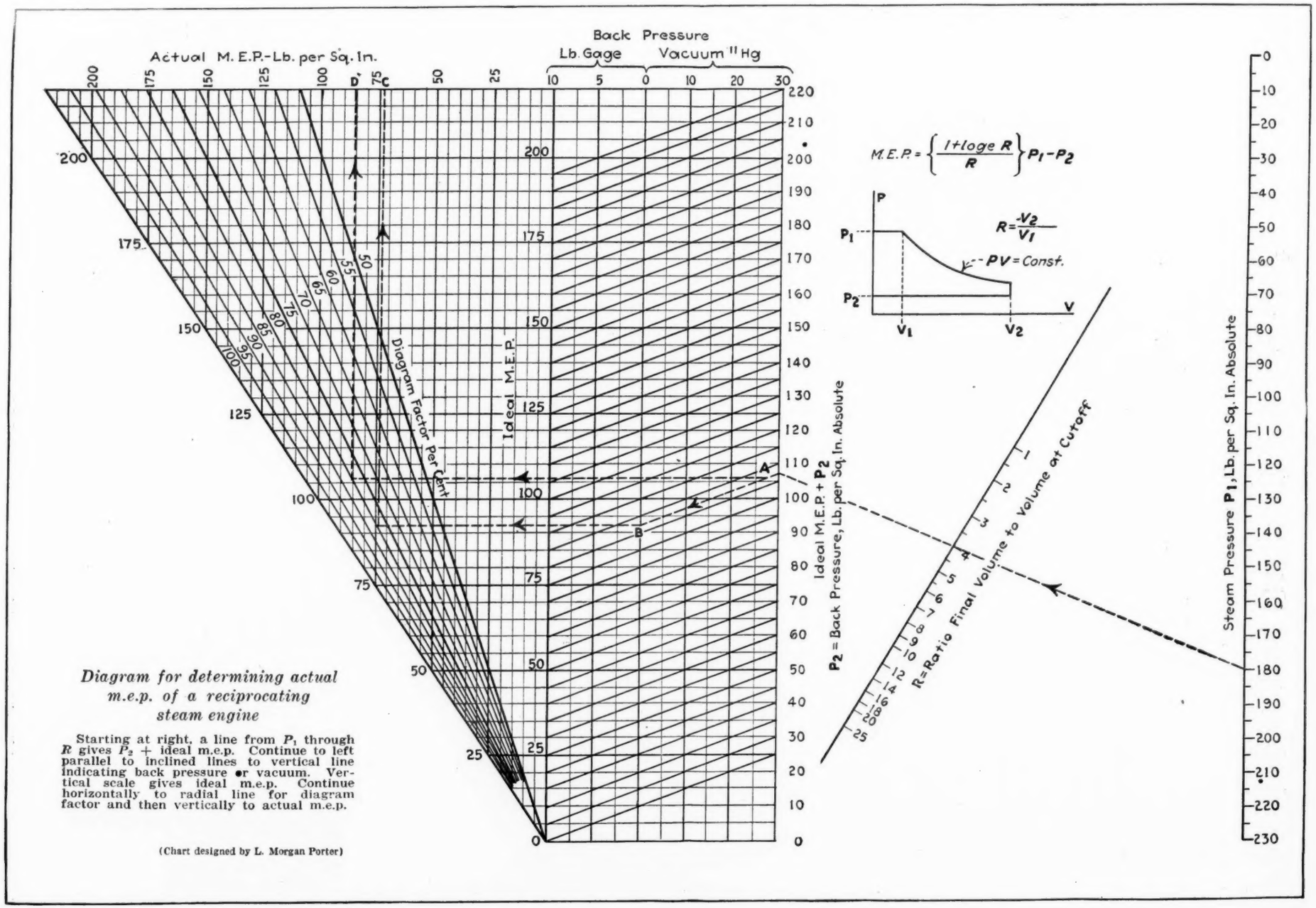


Diagram for determining actual m.e.p. of a reciprocating steam engine

Starting at right, a line from P_1 through R gives P_2 + ideal m.e.p. Continue to left parallel to inclined lines to vertical line indicating back pressure or vacuum. Vertical scale gives ideal m.e.p. Continue horizontally to radial line for diagram factor and then vertically to actual m.e.p.

(Chart designed by L. Morgan Porter)

Is Oil Firing Profitable?

Study of a Power Plant Shows Coal the Cheaper Fuel—Investment of Oil Equipment High

By WARREN VIESSMAN*

THE operating engineer of the average size industrial plant is often required to consider the relative economies of coal and oil as fuel. He may be using either oil or coal at the time of consideration, or perhaps making a selection for a new plant.

Data obtained from salesmen offering oil- and coal-handling equipment are helpful, but alone, are likely to be misleading. In all cases the engineer will be required to determine the costs of coal- and oil-handling equipment as well as the costs of coal and oil. He must decide on the proper equipment for the size and nature of the load in his plant. For instance, boilers having less than 2,500 sq.ft. of heating surface will usually have common grates or hand stokers. Where a number of boilers of large sizes are used, they will, for economical reasons, usually have automatic stokers. In very large plants powdered coal may be economical.

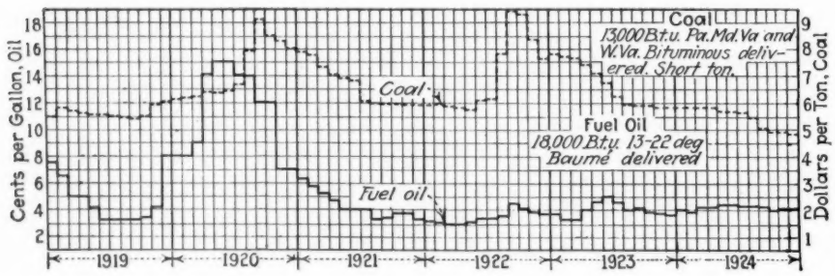


Fig. 1—Coal and Oil Prices at Baltimore

In selecting the proper oil-burning installation, there will usually be a choice as to air atomization, steam atomization and mechanical atomization.

Steam atomization is usually most economical for variable loads on the average size installation where the boilers will not be worked above 200 per cent of their rating. In large boiler plants where there are variable loads and it is necessary at times to carry loads greater than 200 per cent rating, mechanical atomization is used. In this case oil is supplied to the burner at high pressure and forced air is used.

In Fig. 1 are given the prices of 13,000-B.t.u. Pennsylvania, Maryland and Virginia bituminous coal, delivered to private railroad sidings, and fuel oil containing 18,000 B.t.u. per lb. and having a specific gravity ranging from 12 to 22 deg. Baumé, delivered in tank cars to private sidings in Baltimore and vicinity. These prices cover quotations for the last six years. They show the effects of two coal strikes and an oil shortage. From these curves some idea of future prices and price variations can be obtained.

*Consolidated Gas, Electric Light & Power Co.

After a proper selection of coal- and oil-handling equipment is made and the price of the fuels determined, the relative economy of operation can be determined by considering all the relative fixed and operating costs involved. The manner in which various costs affect the comparison and the results to be arrived at is shown by a comparison made for a manufacturing plant where all electric power is purchased and steam is generated for heating the building and for process. This comparison is approximate.

In the plant where the comparison was made there were two 2,500-sq.ft. and one 1,500-sq.ft. horizontal return-tubular boilers. These were mounted high above the inclined water-cooled grates of automatic stokers. The installation was relatively new and in good condition with the exception of the water-cooled grates, which caused considerable trouble due to leaks and were in need of replacement. The boilers were used for building heating and to furnish process steam in the plant. Approximately 1,300 tons of coal was burned annually. The boiler evaporation varied between seven and eight pounds of steam per pound of coal.

One chief engineer at $35 a week, two watch engineers at $30 and two firemen whose wages were $25 a week were employed to keep the plant in operation.

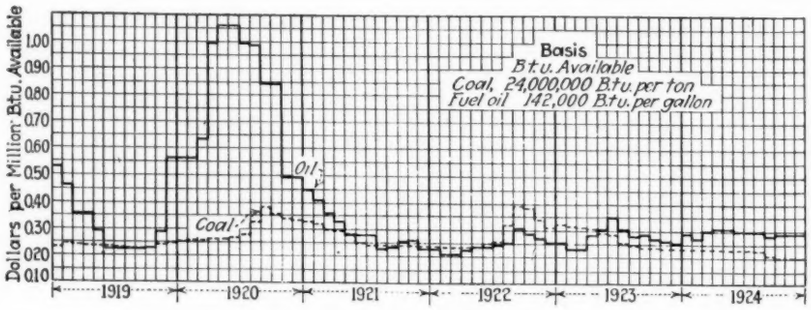


Fig. 2—Economic Cost of Coal and Oil

Ashes were removed from the pits by means of a steam ash ejector and were hauled away in trucks at a cost of approximately $2.50 a ton. The three grates could be renewed for a total cost of about $1,500. This was the only investment required to put the boilers in satisfactory operating condition. To remove the grates and stoker equipment and install good-quality steam-atomization oil burners, oil pumps, oil heater and storage tanks, an investment of $20,000 would be required.

The life of new grates is dependent upon the temperature of operation and the continuity of service. Under the conditions of operation in this plant new non-water-cooled grates were estimated to give five years of serv-

ice. This means that, owing to depreciation of the grates, the investment must be charged off at the rate of 20 per cent a year. To this an interest charge should be added which was placed at 6 per cent. Amortization charges might also be added, but were often neglected, so they were not considered in the tabulation of costs.

The fuel-oil installation would render service for a considerable length of time, the length of service being principally a function of the frictional resistance and thermal and mechanical stresses. However, in determining depreciation charges on investment, obsolescence should be considered. For instance, change in the nature of the steam load or new designs of fuel burning and handling equipment may limit the economical operating life of the equipment. Also fuel oil might possibly become unobtainable at a price where continued operation would be economical. In view of the considerations mentioned the service life of the equipment has been estimated at 10 years. The depreciation charge is therefore 10 per cent. The interest charge is the same as that used for grates.

COMPARISON OF OIL AND COAL BURNING COSTS

Annual Costs With Fuel-Oil Equipment		*Annual Costs With Coal, Stoker Operation*	
Investment:		Investment:	
Complete fuel oil equipment for 3 boilers	$20,000.00	Three stoker grates	$1,500.00
Fixed Charges:		Fixed Charges:	
Interest, 6 per cent; depreciation, 10 per cent; total 16 per cent on $20,000	3,200.00	Interest, 6 per cent; depreciation, 20 per cent; total 26 per cent on $1,500	390.00
Fuel:		Fuel:	
220,000 gal. fuel oil at 4c. per gal.	8,800.00	1,300 tons coal at $5.70 per ton	7,400.00
Labor:		Labor:	
One engineer at $35 per week	1,820.00	One engineer at $35 per week	1,820.00
Two engineers at $30 per week	3,120.00	Two engineers at $30 per week	3,120.00
Auxiliaries:		Two firemen at $25 per week	2,600.00
Fuel-oil heating, fuel-oil atomization, 2 per cent, fuel-oil pump. Total additional fuel cost, 4 per cent	350.00	Auxiliaries:	
		Additional fuel cost, 2.86 per cent	210.00
		Ash removal:	
		195 tons at $2.50 per ton	490.00
		Total cost with coal	$16,030.00
		Savings with coal	1,260.00
Total	$17,290.00	Total	$17,290.00

At present approximately 1,300 tons of coal is used at the plant. Present fuel prices were not taken in working up the comparison. The cost of bituminous coal per short ton, containing 1,300 B.t.u., was available for the last six years. These prices are delivery prices in carloads to sidings of the average large industrial consumer in Baltimore. The price of fuel oil in tank-car lots delivered to industrial sidings was also available, as shown in Fig. 1. Examination of these curves shows the variation in price during a term of years. The coal peaks in September, 1920 and 1922, were due to coal strikes. The drop in oil price after January, 1919, was due to the decrease in war activities. The high oil peak in May, 1920, was due to the unbalance between supply and demand. Relatively little oil was purchased at this top price, there being long-term contracts placed when prices were more favorable.

These price curves are interesting but are not comparable. From them economic comparison curves were drawn as shown in Fig. 2. These are based on 24,000,000 B.t.u. available for furnace heat per ton of coal and 142,000 B.t.u. per gal. of oil available in the furnace. The coal curve assumes 1,000 B.t.u., in 13,000 B.t.u. coal, lost through the grate. These curves show that with the exception of the effects of the war in 1919 and the high oil peak in 1920, the price of oil and coal per million heat units available is nearly the same. Sometimes coal is higher than oil, and sometimes oil is more expensive. At the end of 1924 oil is shown to be decidedly higher than coal. The curves also show that the effect of supply and demand of oil is much greater than the effects of coal strikes.

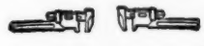
The prices existing in Jan. and Feb. of 1924 were used in the subsequent comparison. These were $5.70 per ton for coal and 4c. per gal. for oil, and 220,000 gal. of oil will contain approximately the same heat as 1,300 tons of coal. With oil equipment the two firemen could be dispensed with and the engineers could perform the duties of both engineers and firemen.

The power to operate the stokers would be about 1 per cent of the total power generated. The ash ejector would require about 2,000 lb. of steam per ton of ashes. Estimating the ash and refuse at 15 per cent or 195 tons, which is about that usually found in a plant of this kind, the total steam required to operate coal auxiliaries exclusive of feed pumps would be 2.86 per cent of the total evaporation.

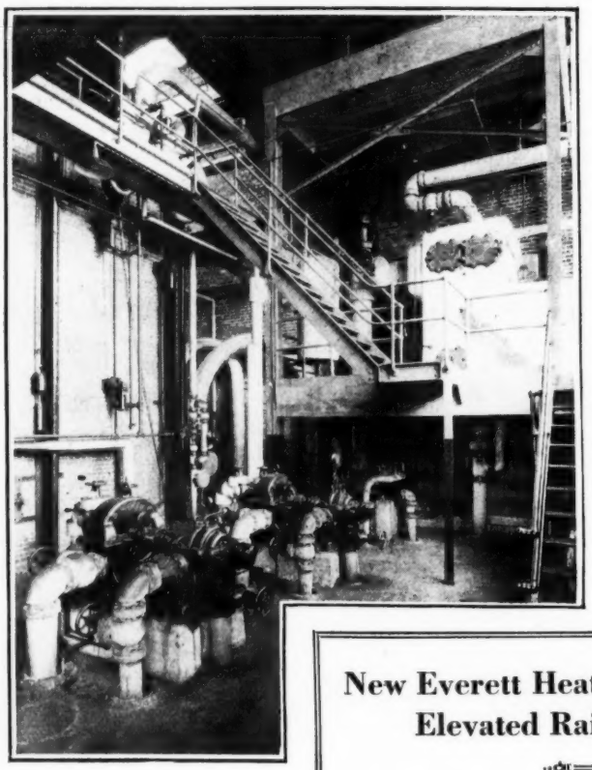
With oil, less than one per cent of the total steam would be required to heat the oil to the proper viscous temperature. The lowest amount of steam required for atomization would be about 2 per cent, and the fuel-oil pumps would take approximately a little over one per cent. This would make the steam required for auxiliaries 4 per cent of the total useful evaporation. Therefore, 4 per cent of the fuel cost for useful work would be chargeable to auxiliaries.

The accompanying tabulation indicates a saving of $1,230 with the continued use of coal. If a better quotation can be obtained on good fuel-oil equipment, the comparison will be more favorable to oil.

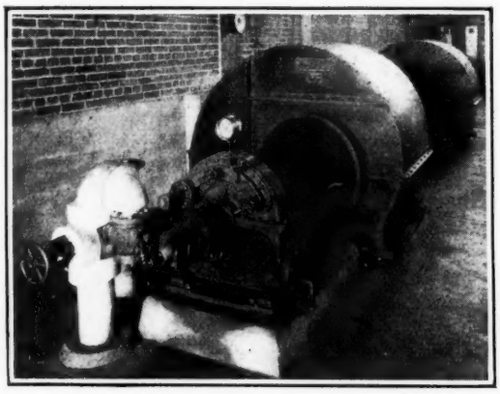
Oil has the additional advantages of better control, less storage space required for the equivalent fuel, greater cleanliness. and the possibility of improving boiler efficiency approximately 2 per cent by better combustion and control with variations in load. This feature has not been capitalized in the comparison because of its uncertain value, but should exert some influence in favor of oil at this plant. Oil would be the most economical fuel for this plant if the investment in oil-burning equipment did not exceed that of coal grates by so large a margin. This would occur if complete new stoker equipment was required.



What is meant by "heat-head"? Take the case of a supply of water on a high plateau which can be piped in a penstock down to a power plant at sea level. There will then be a certain hydraulic head available to produce mechanical energy. Water can be withdrawn at various heights for useful purposes. Unless this water is passed through a small waterwheel at the point where it is withdrawn from the penstock, its hydraulic head is lost so far as the production of power is concerned. The superheater may be considered the "high plateau" for the steam and the exhaust pipe or condenser, the "sea level." If there are economic needs for heat at various pressure levels, it is good engineering to divert such portions of steam as are required, provided the maximum power has been developed in an engine or turbine from the heat head available between the initial conditions and the pressure at which it is withdrawn. —*A. G. Christie.*



Left—Turbine-driven feed pumps and sectional open heater



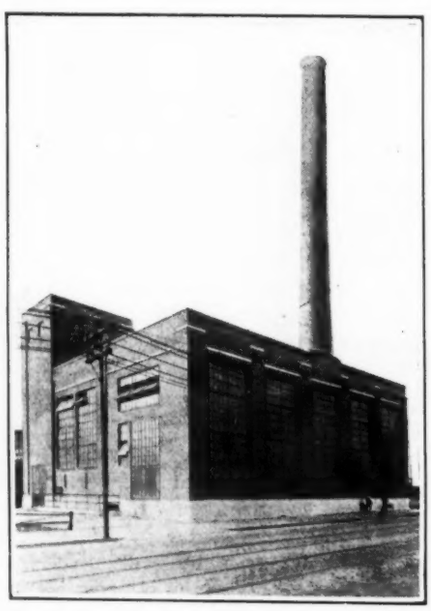
Above—Turbine-driven forced-draft fans

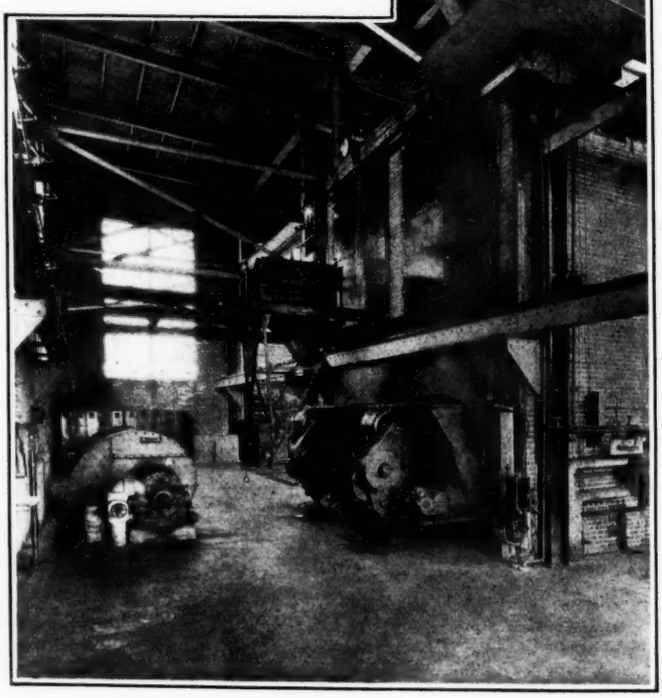
New Everett Heating Plant of Boston Elevated Railway Company

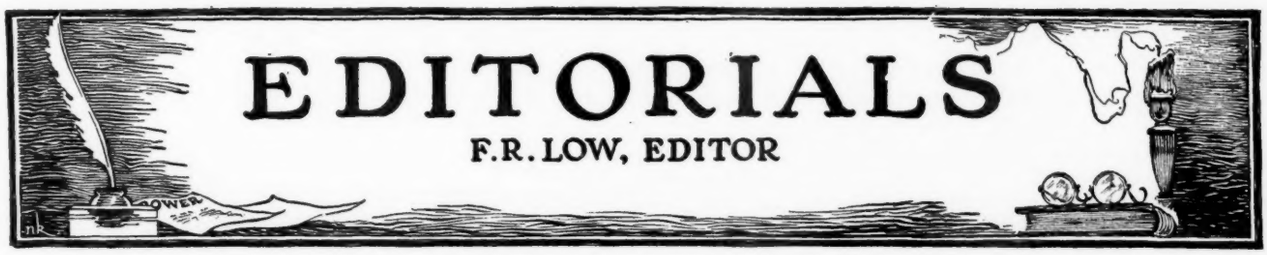
For heating the large repair shops at its Everett Terminal the Boston Elevated Railway Company has just completed this neatly arranged boiler plant. The equipment now installed includes two 3,800-sq.ft. water-tube boilers fired by underfeed stokers with individual motor drive, two turbine-driven forced-draft fans, two turbine-driven centrifugal feed pumps and an open heater of the sectional type. As may be seen from the photographs, this is a workmanlike job of construction. Lighting and ventilation are exceptionally good.

Below — Coal is handled by larry. The stokers are driven by individual variable speed alternating-current motors with gear shift

Below—General view of station. There are no steam-driven generating units in this station, but the room parallel with the sidewalk is occupied by a substation which furnishes power and light to the Everett shops







Easy Sales and Hard Ones

TO BE too easily sold—that is, to be unwisely susceptible to sales enthusiasm—is a mark of business incompetency. Improper purchases represent an economic loss to the community in addition to the more directly felt loss of the purchaser. This is one side of the picture.

Now for the other side! Caution and resistance may be carried to a point where another economic loss thrusts its head above the horizon. If you compel a salesman to waste two hours selling you a fifty-dollar article upon which you were competent to decide in twenty minutes, somebody must pay for that wasted time. That somebody is always the average customer. This holds even where the salesman works on a commission, because commission rates must be such as to pay the average good salesman a comfortable living under the existing conditions. If everybody wastes the time of salesmen, selling costs will go up and the bill must be paid.

So two things are clear: When buyers are "easy marks," there is economic loss; when they waste time owing to lack of understanding or to supercaution, there also is economic loss.

What is the cure? What will buyers be like in the economic Eutopia toward which all eyes are turned. The answer lies in one word—"Education." Granted uniformly intelligent buyers, men of judgment in continual touch with the progress of their field, the "sucker chasers" will quickly die for lack of nourishment, while the salesman with a real proposition can get consideration and a decision without money-wasting delay.

Finally, when the day of the super-intelligent buyer arrives, we will not have the spectacle of a purchasing agent sparring around for a month looking for an additional two per cent discount on a thousand-dollar job of heat insulation, while the bare pipes eat coal at the rate of two hundred dollars a month.

Steam Turbines Easily Placed in Service

STARTING up is an exacting process with many turbines. Much time and close attention may be necessary in order to secure the desired heat distribution and prevent distortion effects. After such a process has been accomplished, the operator may be inclined to heave a sigh of relief with the hope that a long operating interval will ensue, wherein comparatively little of such responsible attention will be required.

Some appear to lose sight of the fact that large units tend to form a class of themselves with respect to starting characteristics, and classify all turbines as requiring careful manipulation when placing in service. Although the total capacity of such machines may overbalance that represented by smaller prime movers, the central-station main units are vastly outnumbered by turbines of industrial and auxiliary capacities. What holds true for large units of more specialized design should not be taken to represent turbine practice in general.

The average turbine, whether of the industrial or the auxiliary class, can hardly be called difficult to place in service. Outside of getting the condenser or exhaust line ready, there is little necessary. Heating up while revolving is not a delicate matter, and only a comparatively few minutes are ordinarily required. One- or two-stage turbines particularly will stand rough usage better, if anything, than similar engines. A large slug of water in the steam would seldom do more than slow down such a turbine if at full speed, while it is doubtful if an engine would escape injury. The process of starting up for the average turbine operator is hardly looked upon as an especially difficult part of the routine.

It is not always realized that a large unit representing greater engineering refinement, more rapidly changing development, greater capacity than the average and perhaps the maximum capacity ordinarily attained under one or more of the design requirements, must be regarded as a more sensitive product; it is fairly entitled to more consideration. Operating periods may ordinarily be long enough, as far as the unit requirements go, to make comparatively few shutdowns necessary during the year. Not only this, but large steam turbines cannot well be compared to steam or internal-combustion engines, since none exist today equal in capacity and performing a similar service.

Boiler Ratings

THERE are two considerations upon which boilers may be rated, their size and their capacity.

The first tells how much boiler one is getting for one's money, the second at what rate the boiler absorbs heat or evaporates water.

The size is usually expressed (in English units) by the number of square feet of heating surface, and a common trade practice in America is to rate boilers in "horsepower" of ten square feet each.

The capacity is expressed by (a) the number of British thermal units that the boiler absorbs per hour or (b) by the number of pounds of water that it evaporates per hour.

The first (a) is a measure of definite performance; the value of the second (b) depends upon the temperature of the feed water and the pressure, temperature and quality of the steam. It obviously takes more boiler capacity to evaporate a given amount of cold water into steam of high pressure and temperature than it does to evaporate the same amount of hot water into steam of low pressure in the same time.

And so, to make boiler performances under different conditions of temperature and pressure comparable, the practice has arisen of reducing given performances to the "equivalent evaporation from and at 212 degrees."

To change a pound of water into a pound of steam, the boiler must absorb and transfer to the water the difference between the number of heat units h already in it and the number of heat units H in a pound of steam of the given pressure and temperature.

To change a pound of water at 212 degrees into a pound of steam of the same temperature and atmospheric pressure (for the expression "from and at 212" as used in this connection means dry saturated steam and not steam of sub-atmospheric pressure superheated to 212 degrees) requires only the heat of evaporation at the pressure of a standard atmosphere, and the formula becomes

$$\textit{Equivalent evaporation from and at 212 degrees} = \frac{W(H - h)}{L}$$

where L is the latent heat, or heat of evaporation of dry saturated steam at the pressure of one standard atmosphere of 760 mm. of mercury or 14.6969 pound per square inch.

But why "from and at 212 degrees?" What bearing has a standard atmospheric pressure on the problem in hand, that of furnishing a base or datum line to which boiler performances may be referred for comparison?

The value of L was given originally by Regnault as 965.7 and so used by Kent in computing his tables of equivalent evaporations in 1885. Peabody gives it as 965.8, 966.3 and 970.9 in his tables of 1888, 1907 and 1909 respectively. Marks and Davis, Callendar, and Goodenough give it in their latest tables as 970.4, 970.7 and 971.7 respectively. The precise researches now in progress at Harvard College, the Massachusetts Institute of Technology and the United States Bureau of Standards will probably develop new values. And such numbers, even if they were fixed and positive, are awkward and cumbersome to use as divisors.

Why not make the denominator of the formula 1,000 and call the result the performance in units of evaporation or of heat transfer or absorption instead of the "equivalent evaporation from and at 212 degrees and atmospheric pressure"?

This would be the equivalent evaporation from and at 163 degrees by the current Marks-Davis tables. It will probably mean the equivalent evaporation from and at some other temperature by Doctor Davis' newer determinations, and does so mean when referred to the tables of other authorities—but what of it? What we are after is a standard unit by which to express the amount of heat transferred from the furnace to the steam, and what can be simpler than expressing it in thousands of B.t.u. unless indeed expressing it in B.t.u. directly?

Using 1,000 as the unit of evaporation or transfer all that one would have to do to refer a given boiler performance to its datum for comparison would be to multiply the difference between the heat H per pound of the steam of the given pressure and quality or temperature and that h of the feed water as given in the table, by the number of pounds evaporated per hour and move the decimal point three places to the left.

A boiler that evaporates 3,000 pounds of 60-degree water per hour into dry saturated steam of 150 pounds pressure would absorb and transfer, or be working at the rate of.

$$\frac{3{,}000(1{,}193.4 - 28.08)}{1{,}000} = 3{,}495.96 \textit{ units per hour}$$

A boiler that evaporates the same quantity of 240-degree water into steam of 300 pounds pressure and superheats it 300 degrees in the same time, would be working at the rate of

$$\frac{3{,}000(1{,}369.2 - 208.3)}{1{,}000} = 3{,}482.7 \textit{ units per hour}$$

The provincial practice of dividing the heating surface of a boiler by ten and calling the result its "horsepower" as indicating its size, is still common, but the more nonsensical practice of reducing its performance to the equivalent evaporation of feed water of 100 degrees into steam of 70 pounds gage, dividing the result by 30 and calling the quotient its capacity in horsepower is little used, although kept alive in the literature of the subject. Measured by such a standard, these performances would be, roughly, 100 horsepower. If, in view of the larger capacity of modern boilers, it were considered desirable to lessen the magnitude of the figures in which performances would be expressed, the divisor or unit of heat transfer might be made 10,000 or 100,000. If long numbers are not objectionable, no divisor need be used, but the performance expressed directly in the number of heat units absorbed, 3,495,960 and 3,482,700 B.t.u. for the two cases assumed. It would take a capacity of 30,000 horsepower to carry this figure up to ten places.

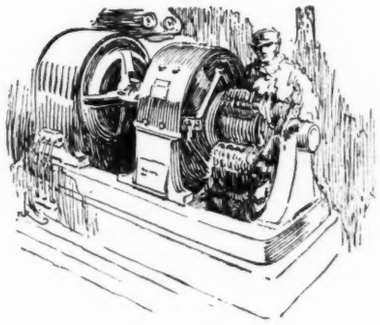
The relation between the physical size of a boiler and the load it is carrying is commonly expressed by stating the load as a percentage of an arbitrary "rated" load which is supposed to be the normal performance of the boiler. For example, it is said that "a boiler is run at two hundred and fifty per cent of rating," etc. This involves a combination of the conventional standards for both size and load.

Why not forget the "boiler horsepower" and the normal or rated capacity of a boiler? There is no need to "rate" a boiler at all. Its size can most easily be expressed in square feet of heating surface; its load in units of evaporation (thousands of B.t.u.) per hour; and its rating in units of evaporation per square foot per hour.

In its code of Definitions and Values and that for the Testing of Stationary Steam Boilers, the Committee on Power Test Codes of the American Society of Mechanical Engineers has taken a long step in the direction of simple and logical practice by adopting the transfer of 1,000 B.t.u. per hour as the unit of evaporation or absorption instead of the cumbersome and indeterminate heat of evaporation at atmospheric pressure.

When purchasing power-generating equipment the efficiency of the apparatus should be given as careful consideration as the price. It not infrequently works out that a small increase in efficiency is worth spending considerable to obtain. Where power is worth one cent per kilowatt-hour, one-half of one per cent improvement in efficiency for a ten-thousand kilowatt load for one year, capitalized at fifteen per cent is worth about thirty thousand dollars. This will vary with the constancy and size of the load and what the power can be sold for at the plant, but these figures show that it may be a penny wise and dollar foolish policy to buy a piece of apparatus simply because it is the cheapest. Of course, there may be conditions surrounding the use of the equipment that will render the foregoing contentions inapplicable.

Practical Ideas from Practical Men



WITH a view to stimulating engineers into the habit of recording for the benefit of brother engineers, unusual occurrences, how these were met and other practical expedients adopted in the operation of their plants, Power has decided to award two cash prizes each month during 1925. One of $25 for the best and another of $15 for the second best practical letter on plant operation or practical kinks received during the month. This is in addition to payment for the contribution at space rates. The winners for March will be announced next month.

Phasing-out High-voltage Circuits with Static Test Method

In present-day distribution systems there are usually many interconnecting loops where high-tension lines are interconnected, and these lines to be reconnected must necessarily be phased out at the point of connection. It is, therefore, essential to have a means of

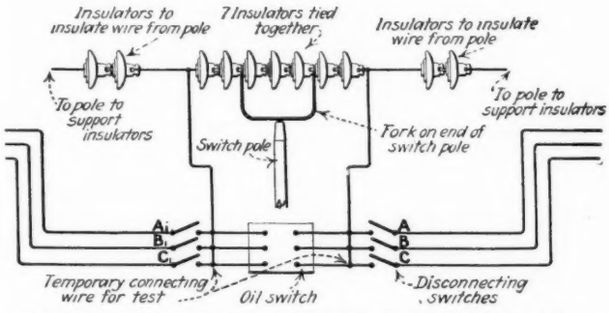


Diagram of connections for phasing out high-voltage circuits

positively determining the phase relation of the two lines in the quickest ways so as to limit the outage time of the lines. The following method will determine the phase relation of any two high potential lines with a minimum time for outage of lines and without the use of elaborate apparatus.

In the figure assume that the disconnecting switches A and A_1 are closed with the oil switch left open, thus energizing the wires leading to the string of insulators and likewise placing an electrostatic charge on these insulators. If A and A_1 are of the same phase relation and a fork on the end of a switch pole is used to short-circuit the three center insulators, a very small arc will be obtained. If we then try forking out the five center insulators, a small arc will also be obtained. This indicates that A and A_1 are of exactly the same phase relation. Now open A and close B, leaving A_1 closed, and by going through the same operations as in testing A and A_1, a heavy static arc will be obtained when the fork is removed. This indicates that A_1 and B are not of the same phase relation. After all the wires have been tested and connected so they correspond in phase relation, the wires connected temporarily to the terminals on each side of the oil switch may be removed and all the disconnecting switches closed; the oil switch may then be closed, paralleling the lines. The theory of the test is that when the insulators are charged by unlike phases, the static charges differ on the insulators, and by forking the insulators out, this charge is broken down and a heavy arc is obtained, while the opposite condition exists when like phases charge the insulators.

There is no set number of insulators necessary to use, but the point to be kept in mind is that each insulator must be of the capacity designed for the voltage of the circuit and that each insulator must be tested separately before the test for phase relation is begun.

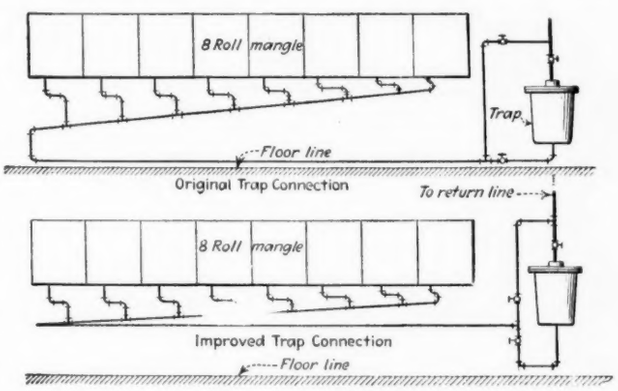
GEORGE F. NUSSER.

Copco, Calif.

Water Seal in Trap Connection Improves Operation

Upon completing the installation of some new machines with steam-heated rolls on which we used the unit return system, a trap on every machine, we had some trouble getting the rolls to heat properly. After a series of tests were made, the representative of the machinery manufacturer concluded that the trouble was due to using superheated steam.

In order to satisfy myself on this point, I ran a line from the saturated-steam connections to one of the ma-



Change made in inlet connection to trap

chines, but the results were the same. After a week of tests with this machine, we tried saturated steam in the dry tumbler, but got practically the same results. We then turned our attention to the trap, and although it appeared to be working properly we did not get the heat in the machine. After making further experiments we decided to alter the connection to the trap

as shown in the illustration. The inlet connection was changed to provide a deep water seal ahead of the trap, and that overcame all our trouble.

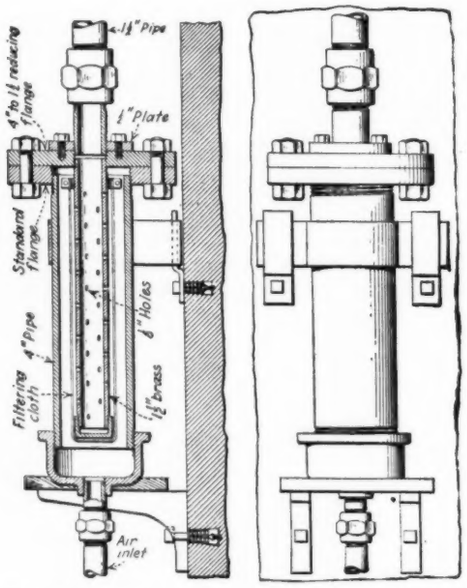
Although the manufacturer's representative still maintains that superheated steam is not as satisfactory for drying as saturated steam, I cannot agree with him. On a series of tests on the dry tumbler the superheated steam proved to be approximately 15 per cent more efficient than saturated steam at the same pressure. According to the manufacturer there should be a difference of 4 to 6 deg. between the inlet and outlet with saturated steam, but on superheated steam we get from 70 to 80 deg. difference and get more heat out of the machine.

J. M. CAHILL.

St. Joseph, Mo.

Improvised Oil Extractor

In our plant there are six automatic temperature controllers operated by compressed air. For a long time we were troubled with oil from the air compressor getting into the controllers and causing them to stick.



Details of oil extractor made with perforated pipe and filtering cloth

We finally overcame this trouble by making the extractors shown in the illustration.

A piece of 4-in. pipe about 3 ft. long, fitted with a reducing coupling on one end and a standard flange on the other, forms the body of the extractor. The central pipe is made from a piece of 1½-in. brass pipe perforated with ¼-in. holes, having a total area greater than the area of the discharge pipe. The pipe is capped at the lower end and is suspended from a flange as shown, the flange being reinforced with a ½-in. plate to give a better thread for the discharge pipe. To extract the oil from the air, gauze or regular filtering cloth is placed around the perforated pipe, two or three layers being sufficient. The flange *A* is removed at regular intervals and the filtering cloth renewed.

This extractor has proved satisfactory in our case and has completely eliminated the trouble of the controllers sticking.

G. M. PHINNEY.

Needham Heights, Mass.

Piping Steam to Pump Receiver Corrects Trouble

Upon first thinking it over, an engineer would naturally consider it an easy matter to buy a combination pump and receiver, Fig. 1, whereby he could let returns from a heating system into the neceiver, then to the pump controlled in turn by a float governor, and pump the returns or condensate into a high-pressure boiler. The arrangement was required to heat the building from a high-pressure boiler through a reducing valve, as in Fig. 2. Under the local conditions, however, it became a puzzle for the time being.

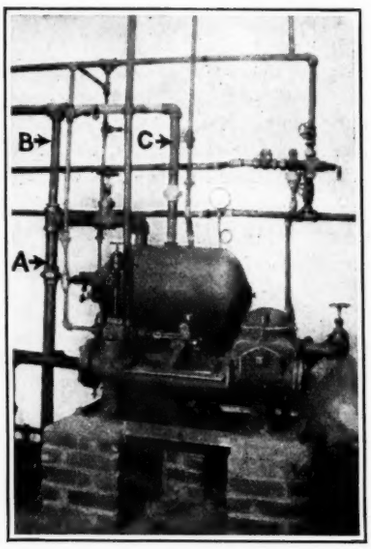


Fig. 1—Returns enter receiver through pipe A while steam is piped at B and C

The one-pipe gravity circulating system contains basement mains running close to the basement ceiling and dripped at intervals into another main close to or at the basement floor. This carries condensate at about the same level as water in a low-pressure boiler that was formerly used. When installing the return pump, it was desired to carry the same water level on the return mains. Therefore, the return condensate pipe *A*, Fig. 2, was set at the receiver to maintain the desired water level. Then the troubles with the pump began.

Pipe *C* in Fig. 1 was originally fitted with an atmospheric safety valve and not connected to *B*. When the

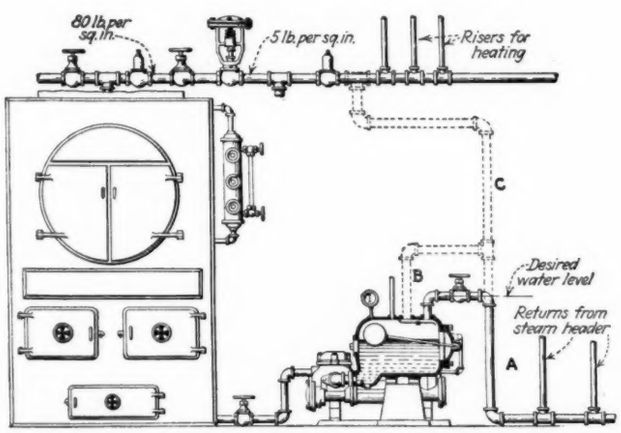


Fig. 2—Receiver pump forces returns of one-pipe heating system into high-pressure boiler

pump was started, the column of steam at house-heating pressure naturally forced all the condensate from the wet return main out through return pipe *A* into the receiver, faster than the pump could pump it, flooding the receiver and passing out through the valve.

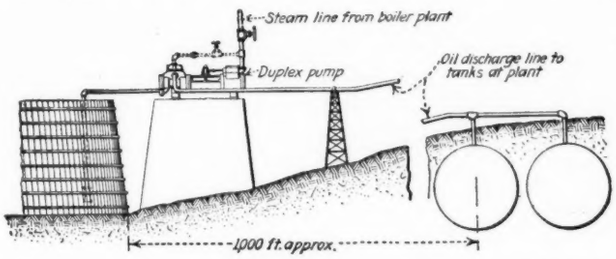
After shutting down the system, it seemed that if I put in a steam column or house-heating pressure line, as at *B*, Fig. 2, it would give the return line *A* the same effect as water column conections on a boiler when both the water side and steam side of the column have the same pressure. After the pipe *B* was installed, the pump worked almost correctly, but not quite, as the receiver was steam-bound as it were and made an awful noise. The atmospheric safety valve on the pipe *C* still opened up. I again shut down, removed the atmospheric safety valve entirely and in its place put the pipe *C* (as will be seen from Fig. 1 more readily) back into the steam side. There was then a balanced return line *A*, and the receiver was not steambound since the pipe *C* both acted as a balancing line for water level in the receiver and relieved excess steam from the receiver.

The steam pressure that is on the building is the same on all parts of the system, and that was why my mechanical gravity pump and receiver would not operate as it was originally intended by the manufacturer. The system of steam heating is a gravity circulating one-pipe system. In conclusion, comments are invited from readers of *Power*, as possibly the plan may be improved in some way, but at present the operation is perfect.

New York City. M. J. MURPHY.

How a Shutdown Was Avoided

As engineers are frequently required to adopt some expedient in order to avoid a shutdown of the plant under their charge, it occurred to me that the following



Arrangement of oil tanks and pumping equipment

incident that took place during my term as chief engineer at a certain power plant in Texas might be of interest to other readers.

The boilers were fired with fuel oil and, as was the usual practice, two large storage tanks equipped with steam heating coils were placed underground adjacent to the plant, with oil pumps in the boiler room. The oil was delivered at the plant in tank cars, which were run alongside the storage tanks and the oil discharged to the tanks by gravity.

On one occasion, during a cold spell in the winter, the engineer reported to the chief that the supply of oil was getting low, only a few hours' supply being on hand. He was told that there would be three cars placed on the spur during the night. Upon arriving at the plant in the morning he found that this had not been done and that there was only about an hour's supply left in the tanks. Upon advising the chief, he was told not to delay any longer, but to transfer a day's supply from No. 3 tank, which stood on the slope of a hill about 1,000 ft. away. For transferring the oil from this tank a duplex pump was placed close to the tank, a well-insulated steam pipe being run from the boiler room to operate the pump and for heating the oil. As there was no time to waste, an oiler was immediately dispatched to get the pump into operation, but in his haste both cylinder heads were knocked out on the steam end of the pump. It now looked as if a shutdown was inevitable, so the chief was called to the scene of trouble.

At a glance he saw that a quick repair was impossible, and to transfer a pump from the plant and get it in operation would take several hours, so he concentrated on some other solution of the problem. It suddenly occurred to him that the oil could be forced through the pipe by turning the steam directly into the line. Accordingly, the lubricator on the steam pipe was disconnected and a ½-in. connection made from the pipe to the air vent on the oil discharge chamber, as shown dotted in the illustration. When the steam was turned on and the oil in the line, which was under a slight head, was put in motion, the oil flowed through the pipe in a continuous stream with the additional advantage that the temperature was increased sufficiently for pumping directly to the burners, and the all important point, a shutdown, was obviated. H. W. ROSE.

Galveston, Tex.

Mixing Raw and Condensed Water in Ice Plants

Many steam-driven ice plants have insufficient distilled water to fill the ice-making demand and live steam must be used in the condenser to make up the deficiency. The use of live steam frequently throws an excessive back pressure on an engine that is already overloaded owing to reduced boiler pressure, and in all cases the boiler plant must meet the extra demand for steam, making rapid inroads into the coal pile.

A few years ago I was up against a problem of this kind, and in order to keep the plant running I decided to try mixing raw water from the city mains with the exhaust steam. We therefore connected a ¾-in. water line to the bottom of the 12-in. exhaust header. The water sprayed into a column of rapidly moving steam, some of which was immediately condensed and the raw water was brought up to the boiling point so that all gases were expelled from the water.

The quality of ice made from this water was just as good as that made when live steam was used to make up the deficiency. The back pressure on the engine was considerably reduced, the boilers steamed easier and the coal consumption was reduced 15 tons a week.

The condensate from the steam coils in the reboilers was trapped to the sewer, allowing considerable good water to go to waste. To stop this loss we removed the coils and replaced them with a cross made of a 10-in. pipe drilled full of small holes through which the steam sprayed into the water that was being reboiled. This gave better results than the old coils had, and there was no loss of condensate.

Our boilers were stoker fired, and we had a great deal of trouble with bridge walls burning out. To overcome this, we laid the bricks in fireclay in which there was mixed one part powdered glass to two parts fireclay, and the top of the bridge wall was covered three or four inches deep with powdered glass. When the boilers were fired up, the glass melted and seemed to fuse the brickwork into one solid mass which would not spall, no matter how hard the boilers were forced.

Napa, Calif. B. C. WEAVER.

Closing Large Gate Valves

Engineers who have to contend with large gate valves, particularly those placed in a horizontal position on steam lines, such as header valves to turbines or sectionalizing valves, undoubtedly find them hard to close steamtight if there is little steam flowing through them at the time of closing. One may pull until one is black in the face—without success, unless one can properly seat the gate.

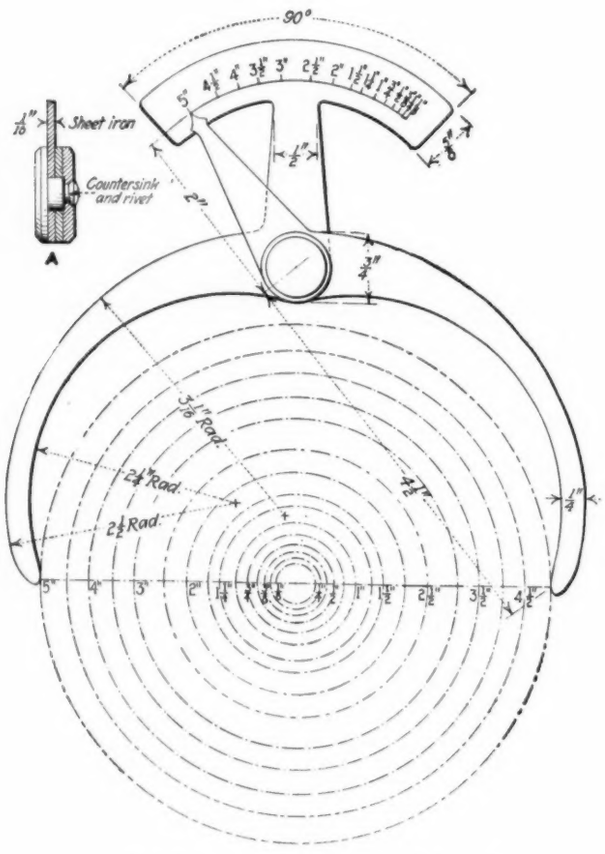
To facilitate this operation I make the following suggestion: Open some convenient drain or bleeder to give a reasonable blow and create a flow, in the line to be "killed." Then slowly close the gate as far as possible and work it back and forth a little until you hear the blow die away. At that point you probably can get another thread or so, but spare the monkey wrench.

H. A. LIVINGSTON.

Holyoke, Mass.

Direct Reading Caliper for Determining Pipe Sizes

The accompanying illustration shows the details and dimensions of a direct reading pipe caliper, which saves considerable time and eliminates guesswork when determining pipe sizes. I have found a caliper of this kind a big help in sketching different jobs around the plant, and there are undoubtedly other readers who could use one to advantage.



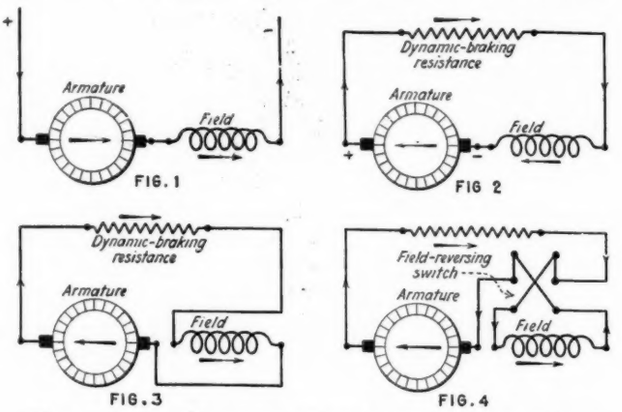
Pointer on caliper shows internal diameter of pipe

GEORGE W. CRONK.

Jersey City, N. J.

Using Series Motors for Dynamic-Braking Application

On a large drawbridge that was operated by a 40-hp. series-wound motor arranged for dynamic braking, it was decided to provide an emergency motor and controller. On this motor an ordinary rheostatic control was used with two contacts to close the armature and field circuit through a resistance, when in the off position, for dynamic braking. When the motor was installed, it was given a test and failed to stop its load when the controller was brought to the off position. It was then decided to trace out the wiring of the other controller, which showed that it had extra contacts for reversing the field leads when in the off position. These reversing contacts could not be provided on the controller on the emergency motor, therefore a double-pole double-throw switch was arranged near the controller so that the operator could reverse the field connections when stopping.



Figs. 1 to 4—Diagrams of series-motor connections

A series motor, when used for stopping its load by dynamic-braking action, must have its field connections reversed, or the action of the current in the field coils will be in a direction to prevent a voltage from building up in the armature when the dynamic-braking circuit is closed. This will be made clear by considering Figs. 1 to 3. A diagram of a simple circuit for a series motor in normal operation is shown in Fig. 1. The counter-electromotive force generated in the armature is in opposition to the applied voltage, so that if the motor is disconnected from the line and connected to a resistance, as in Fig. 2, if the motor keeps on turning it will tend to generate a current to flow in the direction of the arrows. This is in a reverse direction through the field coils from that shown in Fig. 1.

Reversing the current in the field coils, quickly reduces the field magnetism to near zero and causes the current to decrease suddenly to near zero. Therefore, the dynamic-braking effect due to the motor acting as a generator is practically nil. By reversing the field-coil connections as in Fig. 3, the current through these coils will be in the same direction as in Fig. 1, and as long as the motor continues to revolve it will act as a generator when its terminals are connected through a resistance. As previously stated, the trouble was overcome on the series motor in question by connecting a reversing switch in the field circuit as in Fig. 4.

A. V. NARDUCCI, Electrician,

Homestead, N. J. Atlas Finishing Co.

Comments from Readers

Internal-Combustion Boiler

While perusing the March 10 issue of *Power* I ran across Mr. Brunler's account of his internal-combustion boiler and noted that he was apparently getting an efficiency of more than 100 per cent. It occurred to me that in figuring his efficiency, Mr. Brunler may have neglected to take into account the energy supplied to his steam generator via the compressed air fed to his burner.

J. L. FRANKLIN.

Utica, N. Y.

What Causes Pump End Thrust?

We have two centrifugal-type vacuum pumps on a heating system. The pumps are driven by two-phase 60-cycle 220-volt 5-hp. squirrel-cage motors, controlled through a float switch and a two-pole magnetic contactor. The motors and pumps are connected by flexible couplings. When one of the units is shut down, upon opening the power circuit the rotor has a tendency to give a heavy end thrust. The other unit, which has the same amount of end play in the rotor, and is operated on alternate days, does not have the end thrust referred to. Can some reader give me a suggestion as to the trouble?

JAMES GALLAGHER.

Harrisburg, Pa.

Why Did the Tube Bend?

Referring to the inquiry, "Why Did the Tube Bend?" in the March 10 issue, the facts given and the photograph of the tube point to a case of buckling due to a very old cause—incrustation on the water side of the tube.

This conclusion is supported by theory and experience. If scale is permitted to accumulate on boiler tubes, it is almost certain to cause distortion of the tubes in time. Scale is decidedly unresponsive to the expanding action of heat. The result is that if the metal tube is heavily coated with scale on one side, while on the other it is comparatively clean, expansion is bound to take place in the direction of least resistance; that is, away from the heaviest accumulation of scale.

W. HARRIS DAY.

Buffalo, N. Y.

Cost of Atomizing Fuel Oil and Preparation of Pulverized Coal Compared

In the March 10 issue of *Power*, page 367, I noticed an interesting compilation of costs of atomizing fuel oil, the cost for a 45,000-sq.ft. boiler plant being $1.58 per thousand gallons of oil. This figure suggested an interesting comparison to me.

With oil at 8 lb. per gallon this is a cost of $0.395 per ton for mechanical atomizing, which is, of course, the cheapest method.

In *Mechanical Engineering* for March, 1925, on page 228, E. H. Tenney, chief engineer of the Union Electric Light & Power Co., St. Louis, Mo., is reported to have stated that at the Cahokia Station, which is fired with pulverized coal, "the cost of handling and preparation, including maintenance of all coal preparation equipment, was $0.36 per ton.

While it is admitted that these two figures are not exactly comparable, inasmuch as some differences in methods of calculation doubtless exist, it occurs to me that it is worthy of note that the cost of atomizing fuel oil in some cases appears to be approximately the same as the cost of pulverizing coal. The possibility suggests itself that in many cases the cost of atomizing fuel oil will be found to exceed the cost of pulverizing coal.

I do not know as this comparison is a contribution of great value to engineering knowledge, but believe that many engineers will find this thought of interest.

New York City. HENRY B. JONES.

Replacing Cotter Pins

On page 426 of the March 17 issue a description is given of a tool for replacing cotter pins. The statement is also made that the replacing of cotter pins is a rather tedious job by the ordinary method of using a cold chisel and hammer to drive the prongs apart after the pin is in place.

Detail of self-spreading cotter pin

The illustration shows a type of cotter that we have used for years to take the place of the ordinary cotter pin. It is a self-spreading pin, which means that no tools are required to do the spreading. The cotter is inserted in the hole, and with two blows with a hammer the job is done.

This particular pin is made by the American Steel Co., Pittsburgh, Pa.

THOMAS PASCOE.

Norway, Mich.

Note on Brunler's Internal-Combustion Boiler

I was interested to read the account of Brunler's internal-combustion boiler in the issue of March 10 and also the editorial comments thereon. There are possibilities in the working of fixed fluid engines and turbines which render these experiments of Brunler's of high value. The converse procedure of injecting water into the cylinders of internal-combustion engines yields, as my experiments have shown,[1] a supply of heat in the mixed-fluid exhaust discharge, which could be used profitably in the operation of atmospheric turbines.

Assuming the validity of Brunler's experiments showing that efficiencies greater than 100 per cent were obtained in his generators, it is natural of course, as he has done, to inquire into the reason for such an anomaly. His suggestion that there are, perhaps, electrical vibrations produced during the combustion which are converted into useful energy, can, however, scarcely be sustained on scientific grounds. It is well known that in an ordinary gaseous explosion in air the pressure attained is less than would be expected under constant specific heat conditions, and the reason is known to lie in the combined effects of cooling, dissociation and variable specific heat. While engaged on investigations into this question several years ago, I conceived the idea that perhaps some of the loss of pressure was due to the discharge of electrical energy into the surrounding metal and so to earth. This, it will be observed, is the converse of Brunler's idea, who claims that such energy is retained in his boiler. To test the matter at the time, I insulated the explosion vessel carefully on mica supports and took every possible precaution to prevent the discharge of any generated electrical energy to earth, at the same time attempting to measure any such charge on the vessel by connecting it through a sensitive quadrant electrometer. During the explosions the electrometer gave no indications of any such charge whatever, and the insulation of the vessel from earth had no noticeable effect on the pressures produced. Since the effect was a null one, I made no publication of the result and dismissed the idea from my mind.

As the result of investigations, both experimental and analytical, I have come to the conclusion that most of the anomalous results obtained in the flow of heated fluids and in the generation of mechanical energy therefrom, are due to specific-heat variations, and I think it will be found that Brunler's results are due to these also. I presume, of course, that in making his calibrations he has based his figures for steam heat on the current specific-heat tables. From experiments on steam flow through nozzles,[2] there is evidence that as the temperature increases, the specific heat of steam diminishes at a greater rate than is at present believed. Brunler's results lend fresh evidence toward the correctness of this view, for current tables give higher specific-heat values than appear to be justified and so tend to yield the results he has obtained.

Internal-combustion engineers are well aware of the pronounced effect of variable specific heat on the performance of their engines, an effect that could not have been foreseen without the necessary analysis. It is more than probable that steam engineers will have to make more allowance for this factor in their analytical work than they have done in the past. The comfortable thought is that for steam, the specific heat, within and well above present working pressure and temperature ranges, diminishes with temperature and so will give rise to relatively higher thermodynamic efficiencies the higher the temperature. As internal-combustion engineers know to their cost, with gases the converse is the case, the increase of specific heat with temperature resulting in relatively lower thermodynamic efficiencies. For steam also, of course, the specific heat begins to increase with temperature, under sufficiently high temperature conditions, but under boiler generation conditions such temperatures will probably remain impracticable for many a day. WILLIAM J. WALKER.

University College, Dundee, Scotland.

[1] "Thermodynamic Cycles in Relation to the Design and Development of Internal Combustion Motors." Proc. I.M.E. (London), 1920; "Water Injection Experiments on a Gas Engine," Proc. I.C.E. (London) Vol. CCX.

[2] "Critical Pressure Ratio of Gases as Affected by Variable Specific Heat" *Phil. Mag.* (London) October, 1924.

Welding Patches on Boilers

In looking over a Nov. 18, 1924, issue, I noted the failure of some welded mud-ring corner patches on a locomotive-type boiler. There are several statements in this article that are misleading, and I take the liberty of calling attention to them.

In the first place the patches were not applied as they should be. No one familiar with boiler repairs would attempt to apply a lap-welded patch in a mud-ring corner as was done in this case. There is everything against the practice and nothing in favor of it. Such patches should always be cut to fit the opening and butt-welded to the rest of the sheet. Patches applied in this way will last as long as the original sheet. Of course all mud-ring rivets and staybolts should be again applied to reproduce the original construction. It might be pointed out that the A.S.M.E. Boiler Code and the interpretations of it by the Boiler Code Committee approve such welding. Reference is made to Paragraph 186 of the A.S.M.E. 1924 Boiler Construction Code, which reads, in part, as follows:

> Autogenous welding may be used in boilers in cases where the stress or load is carried by other construction which conforms to the requirements of the Code and where the safety of the structure is not dependent upon the strength of the weld.

The author of the article says that to weld on the underside of the patches would necessitate turning the boiler over on the side. This is an error. Overhead welding can be done just as well as welding in any other position and is so done every day by both gas and electric welding. The author further says that oxy-acetylene welding tends to increase the amount of carbon in the weld. This is also an error, and on the contrary, any form of welding, because of its application of high-temperature heat, decreases the carbon in both the weld and base metals. This is so much so that weld metal made from welding rod of, say, 0.4 per cent carbon, contains only about 0.05 per cent.

It seems to me that care should be taken in making statements condemning a process, when it is not the process that is at fault but the method of its application. No one thinks of condemning riveting because riveted joints fall, nor should welding be condemned because of the failure of individual cases of welding. It is entirely right to condemn bad workmanship in both riveted and welded joints. S. W. MILLER.

Long Island City, N. Y.

Testing Welded Pipe Joints

It was with much interest that I read the letter on testing welded pipe joints in the Feb. 10 issue, and I should like to add my testimony that an efficient system of testing should be applied as far as possible to all welded pipe joints in power-plant installations.

Electric and oxyacetylene welding are of relatively recent growth. They were, of course, made great use of during the war, and it was perhaps the need for that large use which resulted in development along what were more or less trial-and-error methods; in many cases the quality of the work has not been of a high standard. This is due, among other things, to the following causes:

1. Lack of efficient training of the operator.
2. Unsuitable generating plant, producing impure acetylene.
3. Indifferent supervision and maintenance of the generating plant and the installation.
4. Defective preparation of the joints to be welded.
5. Unsatisfactory manipulation of the torch.
6. Defective filling materials.
7. Improper heat or other treatment after welding.

It is true that some men become proficient in the art in a shorter time than others, but even with every facility at hand the welding torch is not all that is needed by any means—much experience is needed to become an all-round welder. The commonest defects I find in welded pipe joints are adhesion, oxidation and blowholes. Adhesion means that the added metal has been dropped into the V before the beveled edges are properly molten, and has merely stuck instead of being welded in. Unless the welder secures penetration and cohesion the so-called welded joints will be faulty.

In considering what limitations should be placed on the employment of oxyacetylene or electric welding in power plants, it is necessary to consider the character of the work itself. In the case of a perfect weld —that is, one free from any unsoundness—there is no doubt that the joint in many ways is stronger than a riveted joint, and one possessing at the same time the advantage of being water and steam-tight. But although stronger than a riveted joint, such a joint does not attain the strength of the parent metal. The welded joint consists of iron or steel that has merely cooled down from a state of fusion without undergoing subsequent refining by either mechanical or heat treatment.

Even though such material behaves well under an ordinary tensile test, there can be no doubt that it is much less reliable and satisfactory than properly worked and heat-treated steel. Tests usually show that the material in the welded joint is not the weakest part of a sound weld; the weakest area is generally found a short distance on either side of the weld proper, where the adjacent metal has been exposed to a temperature that leaves it in the weakest and softest condition.

Although an efficient system of testing is recommended as far as possible to all welds, the testing of welds, however thoroughly done, can add but little to the safety of the process. For if a weld can be tested to destruction, it is quite easy to ascertain whether it has been a good or bad one. A mere section cut through it, supplemented by a simple metallographic examination, gives all the data desired, and this may be readily amplified by any number of mechanical tests.

For the sake of safety and reliability testing should be regarded as subsidiary to two other factors—careful selection of the precise method of welding to be employed and of the individual to be entrusted with the job, and constant and vigilant supervision and inspection. Nowhere can the traces of poor workmanship be hidden so effectively, although even the most conscientious workman cannot be certain that a weld is entirely sound. Hence, it would appear that the safeguard lies in the hands of the plant engineer who has to decide whether and where modern methods of welding are to be employed.

Tests, when put into operation, should be designed in relation to the welds made and the purpose they are required to fill, and should be as thorough as possible without overstraining the material. A good test for metal not subjected to pressure is to hammer the welds when cold in order to break superficial skin welds, and then to apply kerosene to the weld. Kerosene is very penetrating and as a rule will show quickly through a defect. It has the advantage of showing clearly by a black spot or stain the exact position of the defect.

For vessels and pipe joints subject to internal pressure it is best to employ a test with compressed air for low pressures up to, say, 30 lb. per sq.in., and hydraulic pressure for higher pressures. A high-pressure test with compressed air is somewhat dangerous and if used, should be applied only by skilled operators under strict conditions. A slight air-pressure test may indicate defects when the welded joint is immersed in water, in which case bubbles appear, or by applying soap solution to the surface so that defects are indicated by soap bubbles. The vise-and-hammer test is somewhat drastic but sometimes useful, to determine the strength of a welded joint and to disclose defects.

The structure of a welded pipe joint may be made to stand out clearly by sawing across the joint, filing or grinding smooth, polishing and etching. An etching solution suitable for iron and steel is composed of 1 part iodine, 2 parts potassium iodide, 10 parts water. This solution should be applied with a brush immediately the polished surface is ready. Adhesions are quickly revealed by sharply defined lines between the filling-in material and the parent metal, whereas a cohered joint shows faintly defined lines and evidence of interlocking. A sound cast-iron pipe joint weld should show no line between the weld and the parent metal when fractured, but when polished and etched, the slight differences in structure usually can be seen plainly. In conclusion it may be mentioned, that if a weld is made with metal of the same composition as the pipe joints to be welded, and if time is allowed for the gradual heating of the work before the welding rod is introduced, and the weld is built slowly from the bottom of the pipe to the surface, there is nothing to prevent a good weld that will give a high degree of efficiency. In many cases the rapidity with which the added metal is run into the V is the feature that prevents a homogeneous joint. Sufficient time is not allowed for the metal to set, knit and recrystallize with the edges of the parent metal.

E. ANDREWS.

Manchester, England.

Most of the oxygen used today is produced from the air by what is known as the liquefaction process. Air contains about 20 per cent oxygen and 80 per cent nitrogen.

Questions and Answers

Conducted by

Franklin Van Winkle

Incondensible Gases Impair Vacuum

What is the reason for having only 28.75 in. vacuum with 30-in. barometer when the condenser temperature is down to 80 deg. F.? *W. C. M.*

Without the presence of air or other incondensible gases, the condenser temperature 80 deg. F. would correspond with an absolute pressure of 1 in. mercury or 30 — 1 = 29 in. vacuum. Poorer vacuum is due to air leakages or incondensible gases not removed by the air pump.

Slip and Negative Slip of Pump

What is the slip of a pump, and what is meant by negative slip? *H. N. C.*

Slip is the difference between the piston displacement, or theoretical discharge of a pump, and the actual discharge. It is generally expressed as a percentage of the piston displacement. When the actual discharge is greater than the theoretical discharge, the difference is called negative slip. This is due to momentum of the water causing continuance of flow at the end of a suction stroke, and is more likely to occur if the suction lift is low and the suction and discharge lines are horizontal or nearly so for considerable distances.

Jumping of Pump

What causes a direct steam pump to jump in the beginning of the stroke when handling cold water? *R. L. N.*

This action generally is due to the presence of air that has become liberated from the water during suction strokes. In place of being reabsorbed by the water or carried along with the discharge, part of the air adheres to surfaces of the clearance spaces in the form of bubbles that cannot be removed except by heating or by brushing off. Sometimes the air bubbles can be dislodged by jarring the water end of the pump. Air thus present is constantly compressed and re-expands at every stroke of the pump, causing a jump of the plunger at the beginning of the stroke.

Overheating of Boiler Heating Surfaces

Why should not the surfaces of the steam space of a boiler be exposed to the heat of the fire as well as surfaces that are covered by water of the boiler? *C. S.*

When heating surfaces that are exposed to the heat of the fire are covered by water, the material is cooled by rapid absorption of the heat by the water of the boiler in raising its temperature and in releasing the latent heat of evaporation that accompanies generation of steam. When the heating surfaces are covered on one side only by steam, the absorption of heat is so slow that unless the steam sweeps over such surfaces at a high velocity, the transmission of heat is slow. Then the material of the heating surface quickly becomes overheated and is likely to become burned away or ruptured from loss of strength from being heated to a temperature nearly as high as that of the fire or heated gases to which the heating surface is exposed.

Shortest Cutoff with D Slide Valve

Why cannot a D slide valve operated by a fixed eccentric cut off before ⅛ stroke? *C. J.*

The D slide valve may cut off earlier, but with a fixed eccentric earlier cutoff usually is considered impractical on account of reduction of the m.e.p. from early release or excessive compression. Shortening the cutoff, with or without adding lap to the steam edges of the valve, requires advancement of the eccentric, and thereby the release and compression are both made earlier. If the attempt is made to correct the release so as to make it later by increasing the exhaust lap, the compression is made still earlier. These considerations have established a limit to which a D slide valve may be economically used. With a fixed eccentric it sometimes is designed to cut off as early as ¼ stroke, but as a rule it is not employed for cutoff earlier than ⅛ of the stroke.

Direction of Driving Horizontal Gear-Driven Pump

Should a horizontal double-acting gear-driven pump be run over or under; and is a pump said to run over or under when the pressure is on the upper or the lower guide? *C. V. B.*

A horizontal engine is said to "run over" when the top of the crankshaft turns away from the cylinder, or as more commonly expressed, when the crank rises in the beginning of a stroke from the head end of the cylinder. The push and pull alternately exerted by the piston then result in downward pressure of the crosshead on the guides. This is preferable to driving in the opposite direction, for when "running under," power transmitted from the piston has a tendency to lift the crosshead and exert pressure against the upper guide, making it difficult to provide lubrication, and there is likely to be pounding from dropping of the crosshead at each end of the stroke.

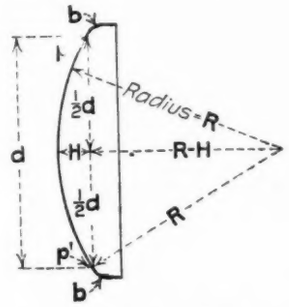
The terms "running over" and "running under" generally are used to designate the direction of rotation of the crankshaft of a pump with respect to the pump cylinder, each in the same way that the terms are used to designate the direction of rotation of an engine crankshaft with respect to the steam cylinder. However, in the case of a pump the crank is the driver of the piston and, to obtain the advantages of receiving pressure from the drive upon the lower guide, the crankshaft should "run under"; that is to say, the top of the crankshaft should turn toward the pump cylinder.

Determining Radius of Dished Head

How is the radius of a spherical bumped head computed from the dimensions of height and diameter?
T. S. M.

For determining the radius of the spherical portion, the dimensions used in computation must be confined to the part of the head which has true spherical form. Referring to the figure, if

R = the radius of the spherical portion of the head, in inches,
d = the length of chord pp^1 which subtends a spherical section of the head in inches,
H = the perpendicular distance from the middle of the cord pp^1 to the spherical surface,



Computation of Radius of Dished Head

then as

$$R^2 = (\tfrac{1}{2}\,d)^2 + (R - H)^2$$

or

$$2RH = \tfrac{1}{4}\,d^2 + H^2$$

$$R = \frac{d^2}{8H} + \frac{H}{2} = \frac{d^2 + 4H^2}{8H}$$

Unless the measurement d is taken between points pp^1 well within the curvature b, b, of the flange, the measurement H may be too large for use in the formula which applies only to a true spherical section.

Excessive Use of Soda Ash

What are the objections to feeding too much soda ash to a boiler? *G. M. P.*

When the water of a boiler contains an alkali like soda ash in larger proportion than necessary to combine with scale-forming impurities, any animal or vegetable oils that may be present are changed into a soapy compound that forms suds and causes foaming. The unbroken bubbles are swept out of the steam space along with the steam and carry water from the boiler. In addition to the danger from the use of wet steam in an engine cylinder, the presence of a strong alkali is objectionable, as it reduces the effectiveness of the cylinder lubricating oil. Another objection to the excessive use of soda ash is that it forms a gummy deposit which is likely to clog gage fixtures and safety valves.

Obtaining Given Cutoff with D Slide Valve

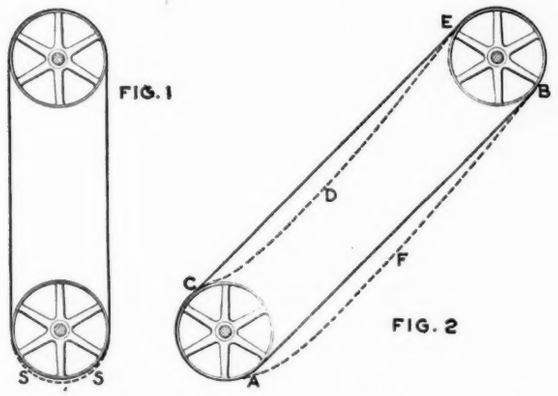
How can a D slide valve be set to obtain cutoff at three-quarter stroke? *W. N. H.*

Make a mark on the crosshead and corresponding marks on the guide when the crank is at each dead center and lay off marks on the guide to represent the position for the mark on the crosshead when the piston is at three-quarter stroke from each end. Remove the steam-chest cover for access to the valve and turn the engine forward until the crosshead has moved from the head end to the position for three-quarter stroke from that end. Then loosen the eccentric and turn it forward on the shaft until cutoff occurs. Temporarily fasten the eccentric on the shaft and turn the engine forward past the crank-end dead center, until the crosshead has traveled the required distance for three-quarter stroke from the crank end. Cutoff probably will not be found to occur at this point. If it does not, move the valve one-half the distance necessary to cause cutoff by changing the length of the valve stem and the other half of this distance by changing the position of the eccentric on the shaft. From changing both valve stem and eccentric each one half, the amount required to obtain the desired point of cutoff on the crank end, the head-end cutoff is unchanged. After setting the crank end, turn the engine forward and test the setting of the head end and again the crank end, each time making one-half of the correction by changing the length of the valve stem and one-half by shifting the position of the eccentric. To take up lost motion in the valve gear, any alteration of the position of the eccentric should be made by approaching the desired position when the eccentric is moved around the shaft in the running direction.

Better Drive Obtained with Inclined Belt

Why is better belt transmission obtained when the sides of the belt are inclined than when one or both sides are vertical? *A. H. M.*

Power transmission is accompanied by a difference of tensions of the tight and slack sides of the belt. The driving side stretches and there is less tension in the slack side. If the sides are vertical, as in Fig. 1, the



Relative contact of vertical and inclined belts

less tension in the slack side may permit the belt to fa l away from the face of the lower pulley as indicated by the dotted line *SS*. When the belt is inclined, as shown in Fig. 2, the increase of tension on the tight side reduces the tension in the slack side with slight reduction of the arc of contact of the belt with the lower pulley. If the lower side *AB* is the driving side, the slack side follows along a curved line like *CDE* and more of the slack side becomes wrapped around the pulley. If the upper side is the tight side, the slack side follows along a curve like the dotted line *AFB* with little loss of contact, and the weight of the slack side increases the friction between the belt and the pulley. Hence, with the same initial belt tension an inclined belt obtains better contact and more power can be transmitted than with the belt vertical.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communication and for the inquiries to receive attention.—EDITOR.]

A new slant on things observed in and out of the power plant

What Happens and Why?

Graphic Records

MEN will probably never be quite as much at home with numbers as with pictures. Long before the child has learned his numerals or even his ABC's, he recognizes pictures of cats, dogs, toys and other things of interest to him. Thus the graph goes back to something almost instinctive in human nature, which doubtless accounts for the great popularity of this method of presenting facts. Tell the average resident of New Hampshire that Mt. Everett is 29,141 ft. high, and he will have a vague notion of a huge mountain, but show him a profile of Everett with his own highest peak, Mt. Washington, drawn beside it to the same scale, and his astonished attention will at once be attracted. He will have a new respect for a mountain that makes Washington look like a knoll.

Pictures Tell More Than Words

It is the same with statistics and periodical records of all kinds. In the form of simple graphs they immediately "get across," whereas the bare data would be fully appreciated only by one versed in figures. The average engineer has had considerable experience in the interpretation of tables of figures, but even he finds that graphs drive home facts whose significance might otherwise escape him.

It is worth remembering that graphic records which the engineer took over from the pure scientist have been in turn largely appropriated by business and in particular by its more progressive executives. While the charts so used are generally of a simple type, they have done much to clarify the thinking of business men on the economic fundamentals. Almost invariably these charts have for their horizontal factor (which mathematicians call the "abscissa") time, expressed in hours, days, months or years. The "ordinate," or vertical factor, may be the amount of a certain product produced, sold or in storage.

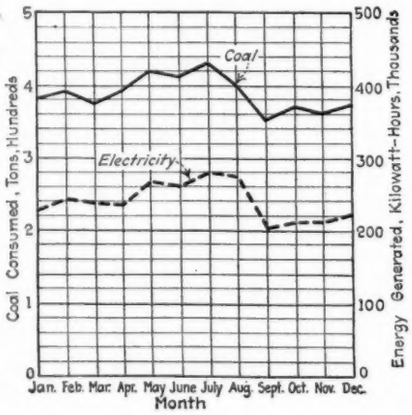
Graphs Used by Business Men

For example, one curve may show the number of barrels of oil produced month by month, another the amount consumed in the country, a third the amount exported and a fourth the amount imported. Such charts give a graphic picture of what is taking place in the industry.

Another class plots the price variations of commodities from month to month and year to year. A study of such charts covering the period of the past twelve years is highly instructive. The effects of the start of the War, our entry into the War, the armistice, the post-war boom and the subsequent depression are all clearly shown in a way that leads one to think about causes.

It is this matter of causes that makes the study of past records of practical value. If one can discover *why* things went well at one time and badly at another, he is in a much better position to regulate his present and future actions in a way that will lead to the most satisfactory results.

While graphs of the type just discussed are ordinarily prepared by business statisticians and used by business men, the engineer can generally afford to give them some attention, particularly if his work is of a rather broad executive nature. Whether he uses them himself or not, his knowledge of the fact that they are familiar to business executives and looked upon as



Graphic record of coal consumed and power generated

valuable adjuncts to business should give him a worth-while hint in the matter of presenting the results of his plant operation to the management. He can safely assume that graphs will be understood by the progressive business man if the abscissas represent the passage of time and the ordinates the production or consumption of some well-known commodity such as coal, steam or kilowatt-hours.

Plotting Operating Results

Where only electric power is generated, curves of coal consumed and current generated, such as are shown in the accompanying chart, tell a lot. An objection to the higher coal bill for July might be met by pointing out the corresponding increase in electricity generated. Conversely, rapid fall in coal consumption from July to September is evidently due mainly to a decreased generation of power. Simple division will show that the coal consumption per kilowatt-hour actually increased from 3.1 to 3.5 lb.

A third curve might well be drawn showing the coal consumed per kilowatt-hour, with which could go an explanation of the reasonable increase in coal consumption per kilowatt-hour with a falling load.

Graphs showing the variation of plant over-all efficiency or of plant B.t.u. consumption per kilowatt-hour have also a considerable engineering value, although the business man can hardly be expected to grasp their full significance without a little education along this line.

Process Steam Plants

Where the plant generates both power and process or heating steam, the curve showing coal consumption per kilowatt-hour has little meaning if it is obtained by dividing the total coal by the total power generated. In such cases curves for total coal, total steam and steam generated per pound of coal roughly measure the performance of the boiler plant.

The coal chargeable to power may be approximated by determining what fraction of the total steam generated is blown to waste from engine exhausts and figuring that same fraction[1] of the total coal consumed. For example, if the plant consumes 100,000 lb. of coal in a certain period, generating 800,000 lb. of steam, of which 200,000 lb. ultimately finds its way to the atmosphere from the unutilized portion of the engine exhaust, power generation might reasonably be charged with one-quarter of the total coal bill, or 25,000 lb. If the corresponding amount of power generated were 36,000 kw.-hr., power would be produced for 25,000 ÷ 36,000 = 0.7 lb. per kw.-hr.

Momentary Records

So far the emphasis has been laid upon the value of the graphic record as a means of exhibiting the plant performance to the management. Its direct value to the engineer is equally great, particularly if it is kept on a daily basis, as is possible where instruments are installed for the measurement of coal and water. The daily record calls attention to conditions that need to be corrected before they have existed long enough to spoil the monthly record.

Still further shortening of the record period should result in increased efficiency. Where certain conditions vary from moment to moment, only a momentary record or indication will suffice for their proper control. This is particularly true of boiler furnace operation where a proper balance between air and coal consumption may in a few minutes change to a serious excess of air with a consequent increase in the flue loss. Boiler instruments are essential if these variations from the best conditions are to be avoided.

[1] This neglects the heat abstracted from process steam by the engines, a quantity so small as to be of little practical importance.

Testing Surface Condensers Equipped With Steam Jet Air Pumps

By J. H. BELL
Sales Engineer, Wheeler Condenser & Engineering Company

The object is to summarize, combine, and explain the procedure, principles, formulas and calculations necessary in making a comprehensive test on steam-jet air-pump equipped surface condensers. A few of the places wherein mistakes are made and how unnecessary work and calculations may be reduced to a minimum, are pointed out. This article deals only with condensers serving turbines, while a subsequent one by the same author will describe tests on auxiliaries.

CONDENSER tests may be divided into two general classifications, those involving the auxiliaries and those not involving the auxiliaries. This article describes tests not involving such equipment and a later one, how the separate tests on the auxiliaries may be, if so required, combined with the test on the condenser itself.

Selection of Instruments

Accuracy is dependent upon the care exercised in correctly placing and reading the instruments, and the precision of the calculations. Each instrument should be selected for the function it is to execute. All thermometers used should read within 0.5 deg. F. and should have stems long enough to extend three-fourths of the way across the inside diameter of the pipe or space from which they are to record the temperature.

Aneroid barometers should be avoided whenever possible, because they are less accurate than mercurial barometers. The best barometer to use is the mercurial barometer with the micrometer adjustment to facilitate readings to the 0.01 inch.

Vacuum gages of the dial type are not accurate enough for test, due to their non-responsiveness to small changes in vacuum. This characteristic of the dial gage is due to its inertia. Any standard type of dial gage will serve for all pressure readings above atmosphere. However, the greatest accuracy is procured when the range of the gage corresponds to the range of the pressure to be measured.

Manometers should be used in taking the pressure readings to ascertain the loss of head through the condenser due to friction. These are usually made in the field because of the difficulty in transporting them. A very good manometer may be made out of a ¼-in. glass tube. In making the bend, care must be taken to keep the cross-sectional area of the tube as nearly constant as possible.

A steel machinist's rule placed on the same board as the glass tube makes a convenient and accurate scale. A gasometer or calibrated bell-mouth orifice with direct-reading manometer should be connected to the atmospheric exhaust from the steam-jet air pump. Fig. 1 shows the manner in which the orifice and manometer are attached.

Calibration of Instruments

The accuracy of all instruments should be ascertained before placing them in their respective positions. The thermometers for temperatures under 200 deg. F. may be calibrated by checking them with a nitrogen filled test thermometer in different temperatures of water.

Those for above 200 deg. cannot be accurately checked without laboratory appliances. However, a rough check may be obtained by placing them together with a test thermometer in ovens or near gas flames. This method of checking the thermometers is not accurate and should not be depended upon.

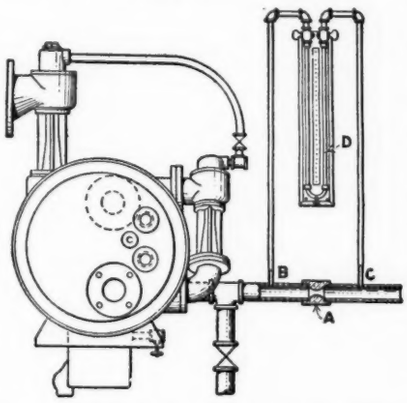


Fig. 1—Measuring exhaust from steam-jet air pump

Pressure drop across orifice *A* measured by manometer *D* connected at *B* and *C*.

The accuracy of the barometer should be determined by taking it to the nearest U. S. Weather Bureau to be checked or by observing readings on the barometer and the temperature next to the barometer every hour and then comparing it with the Weather Bureau reports. Correction for the temperature and elevation must be made between the readings of the barometer being calibrated and the Weather Bureau readings.

All pressure gages should be calibrated by the standard "dead weight" gage tester. If water meters or weirs are used in determining the amount of condensate, they should be carefully checked, the means of checking being dependent upon the type of weir or meter.

Properly locating the instruments will increase the degree of accuracy and reduce the number of calculations. The greater the number of calculations the greater the liability of errors appearing and increasing in magnitude.

Location of Thermometers

The most difficult instruments to locate properly are the thermometers placed in the steam space of the condenser. They must be set so that they are shielded from direct impact of steam currents, water spray from the last stage of the turbine and radiation from the cold tubes and from the hot metal near the high-pressure stages of the turbine.

There should be at least two thermometers placed in the exhaust connection of the condenser. It is always preferable to have two vacuum gage connections in the exhaust nozzle of the turbine, and another should be placed in the condenser shell near the hotwell of the condenser. This gives a means of getting the drop in vacuum through the condenser.

The thermometer for measuring the temperature of the condensate should be placed between the hotwell of the condenser and the condensate pumps. The stem should be located so that, even when the condenser is operating under light loads, it will be completely submerged in the condensate. Vapor exists in the top of the condensate piping on light loads, and experience has shown that the temperature of this vapor does not always correspond to that of the condensate.

The thermometers indicating the temperature of the inlet circulating water may be located near the condenser, but those showing the temperature of the discharge circulating water should be from 50 to 75 ft. away from the condenser to allow thorough mixing of the water strata.

Greater accuracy is obtained by using more than one thermometer for the inlet and outlet circulating-water temperature readings. The thermometers to measure the temperature at the end of each pass should be placed as near the center of the flow of water as possible and should have stems extending at least 6 in. into the waterbox. An inaccuracy always exists in these readings, due to the stratification of the water at these points.

Barometer and Mercury Column

When the barometer is hung next to the mercury column, the altitude and temperature correction between the barometer and the mercury column is eliminated. The barometer and mercury columns must always be hung vertically and have a thermometer placed next to them to obtain the room temperature or that existing around the instruments.

One-quarter inch holes should be tapped in the center of the inlet circulating-water nozzle and of the outlet

circulating-water nozzle. Connections should be made at these places for the manometers used in taking the two pressure readings of the circulating water from which the loss of the head due to friction through the condenser, is determined.

Necessary Preliminaries Before Start of Test

Before a test is run, a static water test should be placed on the condenser and piping, so that air leaks in the condenser may be found. The condenser, if equipped with spring supports, should be blocked up on the foundation before the static water test is applied. This relieves the excessive strain caused by the weight of the water on the turbine exhaust nozzle and on the supporting springs. It also assures that the joints between the turbine and the condenser will not be loosened.

At the same time that the static water test is applied to the condenser, the manholes on the waterbox cover should be opened and the ferrules and packing inspected for leaks. Leaking ferrules and packing may also be found by running the circulating water through the condenser while there is no steam entering it. If there are any leaks, water will run out of the hotwell of the condenser. This is not as good a method of finding the leaks as the first one given, because in the second method a connection in the condensate line must be loosened.

It is always a desirable procedure to paint all joints of the condenser, turbine and piping subjected to vacuum with a heavy asphaltum paint while the unit is under vacuum and before the test is begun. The condenser tubes should be cleaned before the test is run, and arrangements should be made to keep the load on the condenser as nearly constant as possible throughout the test. Readings should be taken simultaneously and at five or ten minute intervals.

Load on Condenser

The best manner of determining the amount of steam condensed is by actually measuring the condensate. This may be done either by weighing it or causing it to flow into containers of known dimensions, or by means of a weir box. These means cannot always be applied in the field, because they may interfere with the heat balance of the station or because the necessary apparatus is not available.

Methods of thermodynamically determining the amount of steam entering the condenser, or the number of B.t.u. entering, that we are chiefly concerned with, are herein described. Methods of approximating the amount of condensate are by (1), water meters of various types, and (2), turbine water rate guarantees.

The method of calibrating water meters depends upon the type. A carefully calibrated water meter is a good means of measuring the amount of condensate.

The water rate guarantees on the turbine are in some cases resorted to for estimating the amount of condensate. With this method, corrections for superheat, pressure and vacuum must be made if they vary from the conditions in the water-rate curve or guarantee on the turbine. Methods for making these corrections are given herein. A commercial steam-flow meter may be used, as a rough check on some other method.

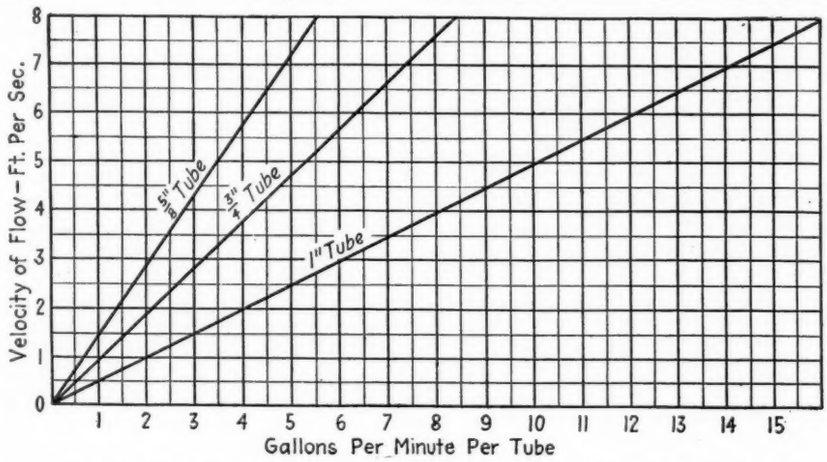


Fig. 3—Curve for obtaining water velocity from single-tube flow and size

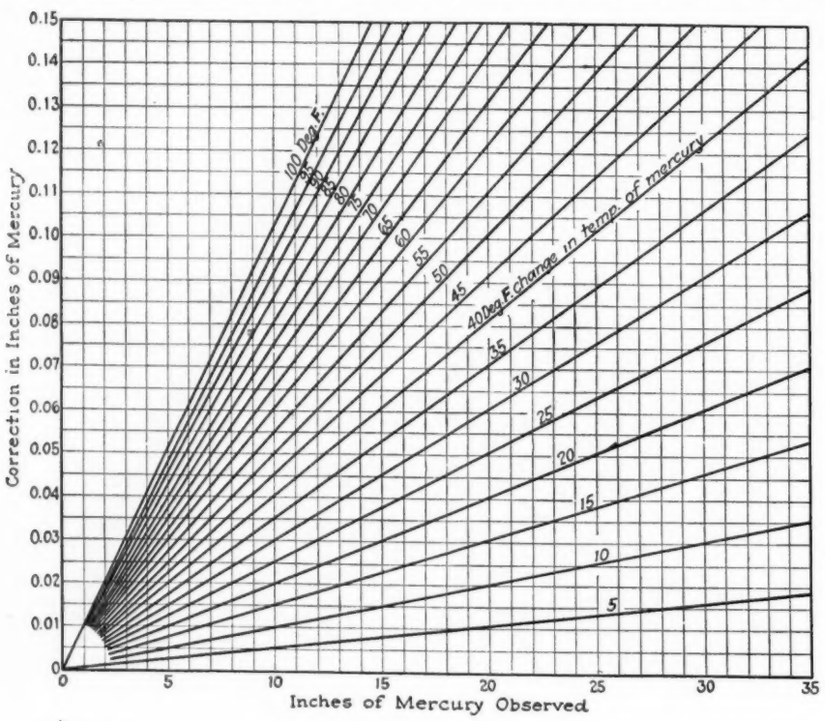


Fig. 2—Barometer readings below require height corrections as at left for temperature changes from observed as in slant lines.

Mercury Reading Corrections

The corrections that must be applied to the mercury readings are the most involved. The clearest way to express these corrections is by example, and the use of the figures and curve will decrease the number of calculations otherwise necessary.

TABLE I—REDUCTION OF BAROMETRIC HEIGHT TO STANDARD TEMPERATURE

Corrections for Relative Expansion of Mercury and Brass Scale

Height of Barometer in Inches	Correction in Inches per Deg. F.	Height of Barometer in Inches	Correction in Inches per Deg. F.
20.0	0.00184	28.0	0.00254
20.5	0.00185	28.5	0.00258
21.0	0.00190	29.0	0.00263
21.5	0.00194	29.2	0.00265
22.0	0.00199	29.4	0.00267
22.5	0.00203	29.6	0.00268
23.0	0.00208	29.8	0.00270
23.5	0.00212	30.0	0.00272
24.0	0.00217	30.2	0.00274
24.5	0.00221	30.4	0.00276
25.0	0.00226	30.6	0.00277
25.5	0.00231	30.8	0.00279
26.0	0.00236	31.0	0.00281
26.5	0.00240	31.2	0.00283
27.0	0.00245	31.4	0.00285
27.5	0.00249	31.6	0.00287

Example 1—Mercury reading 30.12 in., temperature of mercury 41 deg. F.; required, mercury reading at 58.4 deg. standard for a 30-in. mean barometer. The temperature change is 58.4 deg. — 41 deg. = 17.4 deg. Interpolating between the 15- and 20-deg. slant lines

Fig. 2, and finding the intersection with the 30.12-in. ordinate, we read at the left the mercury correction as 0.052.

As the temperature of the mercury has been increased in the standard, this correction must be added to the original reading, and we get, therefore, the corrected reading for 58.4 deg. F. temperature of the mercury at 30.12 + 0.052 = 30.172 in. Hg.

Now, assume that the foregoing reading is the height of a barometer on a certain day.

Suppose further that at the same time the mercury column on the condenser read 28.8 in. with the temperature of the mercury 88. To correct this, first read from Fig. 2 the decimal of an inch correction corresponding to 88 — 58.4 = 29.6 deg. and 28.8 in. mercury height, which equals 0.086. Subtracting this from the original reading, we have 28.8 — 0.086 = 28.714, as the vacuum for standard temperature.

This must now be referred to the 30-in. barometer. The actual barometer was 30.172. The difference, 30.172 — 28.714 = 1.458-in., is the absolute pressure measured in inches of mercury whose temperature is 58.4 deg. Then 30.00 — 1.458 = 28.542 which is the vacuum referred to a 30-in. mean barometer.

The accuracy of the mercury readings may be carried to a greater refinement by applying corrections for relative expansion between the brass scale and mercury, gravity, and capillarity.

TABLE II—CORRECTIONS OF BAROMETER TO STANDARD GRAVITY

As affected by altitude

Corrections to be subtracted in hundredths of an inch

Height Above Sea Level in Feet	Observed Height of Barometer in Inches 20	22	24	26	28	30	32
500				.078	.084	.090	.096
1,000				.155	.167	.179	.192
1,500			.215	.233	.251	.269	
2,000			.287	.311	.335	.359	
2,500			.359	.389	.419		
3,000		.395	.431	.467	.503		
3,500		.461	.503	.545			
4,000		.526	.574	.623			
4,500		.592	.646	.701			
5,000	.598	.658	.718	.779			
5,500	.658	.724	.790				
6,000	.718	.789	.862				
6,500	.777	.655	.934				
7,000	.837	.721	1.005				
7,500	.897	.787	1.077				
8,000	.957	.853					
8,500	1.016	.918					
9,000	1.076	.984					
9,500	1.136	1.050					
10,000	1.196						
10,500	1.255						
11,000	1.315						

Example 2—Reading of the barometer is 29.84 in., and temperature by thermometer 79. In Table I the nearest figure to 29.84 is 29.8 opposite which the correction factor is 0.0027. The change in temperature is from 79 to 58.4 = 20.6 deg. Multiplying this change by 0.0027 gives 0.056 in. as the barometer correction. Subtracting this from 29.84, we get the barometer reading for mercury at 58.4 deg. F. as 29.84 — 0.056 = 29.784 in.

Example 3—Reading of barometer 24.32 sq.in., altitude, 4,000 ft.; required true barometer reading. Referring to Table II, for 4,000 ft. elevation, the correction for a 24-in. barometer is 0.00574 in., and for 26-in. barometer 0.00623 in. Interpolating for a 24.32-in. barometer, we obtain a correction of 0.00582 in. Subtracting this from 24.32, we obtain the true barometer as 24.314 in.

The correction to be applied for capillarity is clearly shown by Table III.

TABLE III—CORRECTION OF THE BAROMETER FOR CAPILLARITY

Diam. of Tube in Inches	Height of Meniscus in Inches 0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08
Corrections to be added in hundredths of an inch								
.15	2.36	4.70	6.86	9.23	11.56			
.20	1.10	2.30	3.28	4.54	5.94	7.85		
.25	0.55	.120	1.92	2.76	3.68	4.72	5.88	
.30	0.36	0.79	1.26	1.77	2.30	2.88	3.48	4.20
.35		0.51	0.82	1.15	1.49	1.85	2.24	2.65
.40		0.40	0.61	0.81	1.02	1.22	1.42	1.62
.45			0.32	0.51	0.68	0.83	0.96	1.15
.50			0.20	0.35	0.47	0.56	0.64	0.71
.55			0.08	0.20	0.31	0.40	0.47	0.52

Turbine Water-Rate Corrections

When the turbine water-rate guarantees are used to estimate the number of pounds of steam condensed per interval of time, the interval usually being one hour, corrections for existing conditions in steam and vacuum should be made so that they will conform to those given in the turbine water-rate guarantee.

For every 10 deg. F. difference in superheat above or below the guaranteed conditions a respective correction of minus or plus 1 per cent of the guaranteed water rate should be made.

Degrees superheat $= T_s - T_p$

in which

T_s = Temperature of steam at throttle;

T_p = Saturation temperature corresponding to steam pressure at throttle.

For every 10 lb. gage difference in pressure of steam at the throttle above or below the guarantee, a respective correction of minus or plus 1 per cent of the guaranteed water rate is necessary. For every 0.1 in vacuum difference above or below the guaranteed condition a respective minus or plus correction of 0.7 per cent should be made to the guaranteed water rate for ranges of vacuum between 27½ and 29 in.

The application of the three foregoing corrections when necessary, will give a corrected water rate on the turbine that will be found to be fairly accurate. However, this method of determining the amount of steam supplied the condenser should be used only when there is no direct way of measuring the condensate and when the blading of the turbine is in good condition.

Formulas and Calculations Involved in the Test

The formulas for calculating the heat supplied to the condensers per hour are very clearly presented in the Test Code for Condensing Apparatus, as formulated by the American Society of Mechanical Engineers, which is quoted below:

Heat supplied to the Condenser per Hour—The size of the condensing equipment should be determined by the amount of work it is to perform; that is, the amount of heat it is to remove. This depends upon the heat content of the steam as delivered to the condenser, an amount seldom specified, although of prime importance.

The heat supplied to the condenser is that supplied to the prime mover, exhausting to the condenser, less that converted into work and lost by generator losses, friction, radiation and other wastes, not readily determined. It is simply expressed by the following formulas (where the condenser is bolted direct to the turbine exhaust opening):

(a) For a simple non-bleeding and non-reheating turbine,

$$H_c = H_t - (3{,}413/SE)$$

(b) For a reheat, non-bleeder turbine,

$$H_c = H_t + (h_r - h_c) - (3{,}413/SE)$$

in which the expression $(h_r - h_c)$ is repeated for each stage of reheating.

(c) For a bleeder, non-reheat turbine,

$$H_c = \frac{H_t W}{W - (w_1 + w_2 + \ldots w_n)} - \frac{3{,}413\ KW}{E[W - (w_1 + w_2 + \ldots w_n)]} - \frac{w_1h_1 + w_2h_2 + \ldots . w_nh_n}{W - (w_1 + w_2 + \ldots w_n)}$$

(d) For a bleeder and reheat turbine,

$$He = \frac{H_t W}{W - (w_1 + w_2 + \ldots w_n)} + \frac{W - w(h_r - h_e)}{W - (w_1 + w_2 + \ldots . w_n)} - \frac{3{,}413\ KW}{E[W(w_1 + w_2 + \ldots w_n)]} - \frac{w_1h_1 + w_2h_2 \ldots w_nh_n}{W - (w_1 + w_2 + \ldots w_n)}$$

In the equation given above

H_c = B.t.u. per lb. of steam at the prime-mover exhaust;

H_t = B.t.u. per lb. of steam at the prime-mover throttle;

S = Steam supplied to throttle of prime-mover, lb. per kw. hr.;

E = Mechanical and electrical efficiency of prime-mover complete, including all friction, electrical loss, windage, radiation, etc.;

h_r = B.t.u. per lb. of steam at point of re-entrance to turbine after reheating;

h_c = B.t.u. per lb. of steam after partial expansion in the turbine at point of extraction for reheat;

W = Total steam supplied to throttle of prime-mover, lb. per hour;

$w_1, w_2 \ldots w_n$ = Steam bled from first, second, and nth. bleeder point of turbine, lb. per hour;

$h_1, h_2 \ldots . h_n$ = B.t.u. per lb. of steam at the first, second, and nth. bleeder point of the turbine;

KW = Load on prime-mover in kilowatts.

In using the formulas given for determining the heat absorbed by the condenser, the heat carried away by the condensate should be subtracted from H_c, or heat absorbed by condenser.

$$H_c = H_e - (t_c - 32)$$

in which

H_c = B.t.u. per lb. of exhaust steam absorbed by condenser and caried away by the circulating water;

t_c = Temperature of condensate.

If the prime-mover steam rate is

given in pounds per horsepower-hour, the constant 2,545 is substituted for the constant 3,413. The value of the quantity E varies with both the type and size of prime-movers. A rough check upon the quantity of heat so determined may be made by the following formula:

$$H_c = W_1(T_2 - T_1)$$

in which

H_c = B.t.u. supplied condenser;
W_1 = Weight of circulating water per lb. of steam condensed;
T_2 = Temperature of circulating water leaving condenser;
T_1 = Temperature of circulating water entering condenser.

The loss of head through the condenser due to friction is the difference between the pressure readings of the manometers placed on the inlet and outlet circulating water nozzles. If there is a positive or negative head of water in the tubing from the manometer to the ¼-in. tap in the circulating-water nozzles, correction should be made for the static head that will exist on the manometer. There is no exact way of determining the loss of head where the circulating water leaves one pass and enters another. However, a loss of head of two feet is generally assumed.

Total loss of head through the condenser is the sum of total friction head and the vertical distance in feet between the center lines of the circulating water nozzles.

Both the arithmetical and logarithmic mean temperature difference should be used in making up the results of a test to facilitate the comparison with other tests. The formulas follow:

Arithmetical mean difference =

$$t_s - \frac{t_o + t_i}{2}$$

Logarithmic mean difference =

$$\frac{t_o + t_i}{\log_e \frac{t_s - t_i}{t_s - t_o}}$$

in which

t_s = Temperature in steam space, deg. F.
t_i = Temperature inlet circulating
t_o = Temperature outlet circulating water.

The main difference between the results of the two formulas are, that a constant steam temperature throughout the condenser and a uniform rise in temperature of the circulating water from its entrance to exit are assumed in the arithmetic mean, while the logarithmic mean difference is based upon a constant steam temperature throughout the condenser and a uniform heat transfer throughout the condenser.

Tests made recently have shown that neither the temperature nor heat transfer throughout the condenser is uniform.

The average heat transfer U throughout the condenser and the gallons per minute of circulating water as calculated by the thermal method, are derived by the following formulas:

$$U = \frac{N \times H_c}{S \times T_n} \qquad g.p.m. = \frac{N \times H_c}{500 \times R}$$

in which

N = Number of pounds of steam per hour;
H_c = Number B.t.u.'s absorbed by condenser as above derived (usually about 950);
S = Number of square feet surface in condenser;
T_n = Mean temperature difference (logarithmic or arithmetic);
500 = A constant (exactly 498);
R = Rise in temperature of the circulating water through the condenser.

The vacuum drop through the condenser is the difference between the vacuum reading in the exhaust nozzle of the condenser and the vacuum reading near the hotwell.

The method of calculating the total pressure in the condenser, due to the steam and air, is best given by an example. The formula used is the one for a perfect gas, which is:

$$P = \frac{RT}{V}$$

in which

P = Absolute pressure, lb. sq.ft.;
R = 53.34 (for air);
T = Absolute temperature in deg. F.;
V = Volume of 1 lb. of air, cu.ft.

Example 4—Assume the temperature in a condenser to be 115 deg. F. Then if the condenser contains only water and saturated steam at this temperature, the pressure within the condenser would be 2.99 in. mercury, as can be found from the steam tables.

Example 5—Let it be presumed that upon measuring the temperature and volume of vapors leaving the condenser it is found that at the vacuum pump suction this temperature is 115 deg. and that every pound of water vapor has mixed with it one-fourth pound of air.

The pressure due to the air alone, if free to expand in the condenser, with no steam present is found as follows:

One pound of saturated steam at a pressure of 2.99 in. mercury occupies a volume of 231.9 cu.ft. This must also be the volume occupied by the one-fourth pound of air mixed with it if allowed to expand with no steam present. The temperature of this air is that of the steam (115 deg. F.) Then from the law of ideal gases the pressure P of the air in the condenser is

$$P = \frac{53.34 \times (115 + 460)}{4 \times 231.9} =$$

33.06 lb. per sq.ft.

and therefore the pressure p of the air alone = 0.46 in. mercury. Then the total pressure in the condenser will be 2.99 + 0.46 = 3.45 in. of mercury at 32 deg. F. under actual conditions. If the barometer reads 29.92 in. mercury at 32 deg., the vacuum will be 29.92 — 3.45 = 26.47 in. based on mercury at 32 deg. or 26.54 in. mercury referred to a 30-in. barometer at 58.4 deg. F.

The number of square feet of surface F in the condenser is most easily calculated by the following method:

$$F = c \times N \times L$$

in which

c = 0.2618 for 1-in. tubes;
0.229 for ⅞-in. tubes;
0.1963 for ¾-in. tubes;
0.1636 for ⅝-in. tubes;
0.1309 for ½-in. tubes;
N = Number of tubes in condenser;
L = Length of tube in feet (between tube heads).

The inside cross-sectional area A in square feet of the tubes in each pass is:

$$A = k \times N$$

in which

k = 0.0044 for 1 in. No. 18 Stubs gage tubes;
0.0033 for ⅞-in. No. 18 Stubs gage tubes;
0.0023 for ¾-in. No. 18 Stubs gage tubes;
0.0015 for ⅝-in. No. 18 Stubs gage tubes;
0.0009 for ½-in. No. 18 Stubs gage tubes;
N = Number of tubes in each pass.

The velocity of circulating water V in feet per second in each pass is found by dividing the number of cubic feet per second of circulating water going through the condenser by the number of square feet of area open to the flow of circulating water in the pass. The velocity may also be found by dividing the gallons per minute of circulating water by the number of tubes in the pass and using this result in conjunction with the curves of Fig. 3.

Discussion

Every condenser presents its own particular characteristics and problems. These are nearly always solved while the condenser is being designed, but there are cases where tests must be run on the condenser after it is installed and operating to bring its performance to the proper refinements.

The temperature rise of the circulating water should be the same in all passes of the condenser, unless it is wrongly designed. If the temperature rise is not the same, there is not the proper distribution of steam, or there is the condition of air-blanketing.

The improper distribution of steam is due to insufficient steam lane space, poor location of the lanes, or short-circuiting of the steam. The condition of air-blanketing is caused by improper location of dry air baffles and air removal ports, or by the short circuiting of the air to the air removal manifold.

When these conditions exist in a particular condenser, that condenser must be analyzed separately to overcome the discrepancies. The discussion in this topic is necessarily a general one applying to surface condensers as a whole.

Westinghouse Company To Assist Buyers

The Westinghouse Acceptance Corp., a $2,000,000 enterprise, has recently been organized to assist buyers of Westinghouse Electric & Manufacturing Co.'s products in the financing of time-payment sales of their electrical apparatus, as announced in the press. Offices of the corporation are in Pittsburgh, Pa., and branch offices will be opened in other cities as the requirements develop. E. M. Herr, president of the Westinghouse company, is chairman of the Board of Directors of the company and F. A. Merrick is president. G. Brewer Griffin, recently manager of the company's automotive department, will have charge of the new company as vice-president and general manager.

Views of Interested Persons Sought by Muscle Shoals Commission

Decision in Regard to Temporary Sale of Power Expected at Meeting To Be Held Week of May 4— Six Copies of Views Requested

LETTERS to a large number of persons having special knowledge of the possibilities of Muscle Shoals and to others who are interested in public affairs generally, were mailed April 22 by the President's Muscle Shoals Commission. It is expected that a meeting of the Commission will be held during the week of May 4, at which time the Commission probably will agree upon the answer which is to be made to the Secretary of War in the matter of the temporary disposition of the power.

It was announced at the offices of the Commission that among those to whom the request for suggestions was sent are the following: Henry Ford; William Green, president, American Federation of Labor; Frank O. Lowden; Alexander Legge, president of the International Harvester Co.; George Peek, Moline Power Co.; E. F. Price, Union Carbide Co.; Thomas W. Martin, president, Alabama Power Co., and to the Deans of the various state agricultural colleges. The text of the letter follows:

"This Commission has been appointed by the president to 'assemble reliable information as to the best, cheapest and most available means for the production of nitrates and other products for munitions of war, and useful in the manufacture of fertilizers and other useful products by water power, or such other power as may be best and cheapest to use,' as it applies to the Muscle Shoals development.

"Your interest in public affairs prompts us to write to you, informing you that we would be glad to have you submit at your earliest convenience your views on this question. We wish to assure you that any assistance you can give us in bringing about a final and satisfactory solution of this problem will be greatly appreciated. We are sure that your co-operation in this will be helpful, and trust that you will submit your views before June 1 if possible.

"It would be very advantageous to the Commission if you would be kind enough to send six copies of your observations, so that each member of the Commission could have a copy, and make a personal study of whatever you may suggest.

"If it appears advisable to take this matter up with you personally and to consult with you further, would it be agreeable to you to appear personally before our Commission?"

Conowingo License Not Yet Issued by Commission

The license recently authorized by the Federal Power Commission covering the proposed development at Conowingo on the Susquehanna River, has not been issued as yet pending the receipt of a report on the intercorporate relationships involved in the handling of this project and in the distribution of power. The applicants, the Susquehanna Power Co. and the Susquehanna Water Power Co., have as yet to justify the amount claimed for prelicense costs. It is understood, however, that satisfactory reports have been made in this connection and that the actual issuance of the license will take place in the near future.

Arkansas Enacts License Law for Professional Engineers

Arkansas is the latest state to enact a license law for professional engineers, the law having been passed at the session just closed. It becomes effective June 11, and applies to engineering involving public health and safety. It is to be administered by a State Board of Registration for Professional Engineers, appointed by the Governor. Chief among the provisions are: An application fee not to exceed $15; applicants for registration must have had four years' active engineering experience (two years of which may be compensated for by graduation from a technical school of recognized standing), and must be qualified to design and build important engineering structures; an additional fee not to exceed $10 is required for certification; certificates of registration will be issued without examination until Jan. 1, 1926; annual renewal of certificates is required, $10.

Reciprocity is cared for by a section allowing issuance of certificates to non-residents upon proof of registration in another state, the cost to be $10. Corporations may practice if the person or persons in charge are registered.

Exemptions from registration are granted those practicing under 30 days in the state; non-resident consulting associates of registered engineers whose consulting work in that capacity does not exceed 30 days; employees of registered engineers or of those exempt under the terms of the act; officers of the United States Government and officers of the state or any subdivision thereof practicing solely as such.

Revocation of license for cause is provided for.

Members of Muscle Shoals Commission, left to right—R. F. Bower; former Senator N. B. Dial; former Representative J. C. McKenzie, chairman; William McClellan; Prof. H. A. Curtis

A.S.M.E. Honors W. R. Warner for His Aid to Science

Worcester Reed Warner has been elected to honorary membership in the A.S.M.E. This tribute comes to him in recognition of the high service he has rendered in increasing the efficacy, thorough, careful design and excellent workmanship of astronomical and other scientific instruments and machine tools, "the master tools of industry."

Mr. Warner with Ambrose Swasey founded the well-known firm of Warner & Swasey in Cleveland, Ohio, in 1881, for the manufacture of machine tools, optical instruments of precision, including range finders, gun sights, astronomical telescopes, etc. They designed and constructed the 36-in. Lick telescope, 40-in. Yerkes telescope, and the 72-in. telescope for the Dominion of Canada, at Victoria, B. C.

Mr. Warner was born in Cummington, Mass., in 1846, studied in the district schools there and learned the machinist trade at Boston and Exeter, N. H. He was foreman with Pratt & Whitney Co., Hartford, Conn., during the years 1870-1880. Along with many other mechanics during this time he became a student of astronomy and experimented in building telescopes as a recreation. This avocation soon became of real interest to him, and together with Ambrose Swasey a firm was founded for the making of such instruments, in Cleveland. He is a past president of the A.S.M.E., Civil Engineers Club, Cleveland. Fellow of the Royal Astronomical Society of England, A.A.A.S., member of the British Astronomical Society, and many other scientific and technical societies.

German Engineers to Hold Meeting at Augsburg

The Verein Deutscher Ingenieure (V.D.I.) will hold its 64th annual meeting at Augsburg on May 9-11. Professor Naegel, of Dresden, will read a paper on "Research Engineering in the United States." Individual seminary sessions will discuss problems relating to Diesel engines, steam boilers, combustion as especially applied to inferior fuels, and the utilization of waste by-products as fuels. The City of Augsburg has arranged a public works exhibit consisting of models and plans of municipal engineering works. Models of waterwheels and hydraulic lifts as employed between the Fifteenth and Eighteenth centuries will be shown.

Charles E. Hughes Retained as Counsel in Interest of New York State Water Power

Alleged Federal Invasion of State Water Rights Under Esch Law Opposed by Attorney General of State

CHARLES EVANS HUGHES, former Secretary of State, was retained by New York State as counsel to handle litigation to carry out provisions of the Federal Water Power Act relating to development of water power on navigable streams. Announcement to this effect was made by Attorney-General Albert Ottinger as the result of a conference with Mr. Hughes in New York City, during which Mr. Ottinger emphasized his determination to clear up finally the matter of New York State's rights under the Federal act.

Under the provisions of the act the government is authorized to take over any present or prospective water-power development on navigable streams, but such action, the State of New York contends, would strip the state of its rights over water-power developments at Niagara Falls and along the St. Lawrence River.

Preservation by the state of "transcendent and pre-eminent rights of ownership, exercise and control of present and future water power developments" was responsible for the retention of former Secretary Hughes as counsel, Mr. Ottinger said:

"The scope of the question involved is far greater than the contention of the State of New York," he added. "The issue presents timely opportunity to fight for the preservation of State's rights as against the steady encroachment and centralization of power in the federal government—a contest which will enlist the united sympathy of all the states."

The question arose last year, during the term of Attorney General Carl Sherman, but after conversations between state and federal officials it was decided that the situation should remain in statu quo until some overt act had been committed and the case should be taken to the courts.

Fuel Savings Conference May 13-14

A Fuel Savings Conference and Power Show will be held under the auspices of the Combustion Engineering Division of the A.I. & S.E.E. on May 13-14, at the William Penn Hotel, Pittsburgh, as announced in *Power* at length in the issue of March 3, page 357. Papers of interest to *Power* readers will be presented and discussed by prominent engineers. One whole day will be devoted to "Combustion Control." This subject will be discussed by C. H. Smoot, B. G. Bailey, Thomas Peebles and G. S. Carrick. Another paper will be "Insulation of Hot Surfaces and Furnace Walls," by L. B. McMillan, consulting engineer, Johns-Manville Co. A paper on "By-product Fuels" will be presented by F. O. Schnure.

A new feature in connection with the Fuel Savings Conference will be the Power Show, which is also to be held at the William Penn Hotel.

Giant Power Scheme Bills Fail of Passing

None of the bills introduced in the Pennsylvania Legislature in promotion of the Giant power scheme, advocated by Governor Pinchot, have passed the Legislature nor is there any prospect of any of them passing, it is announced at Harrisburg.

Use of Barge-Canal Power Questioned

Four specific instances where surplus waters of barge canal are being used for power purposes without adequate return to the state were cited in a brief filed with the Water Power Commission on April 20, by Col. Frederick Stuart Greene, superintendent of public works. The points specified are:

Medina, Orleans County, double use of water by S. A. Cook & Co. and Western New York Utilities Co.; Rochester, inadequate return from Rochester Gas & Electric Co. for volume of water used; Fulton, Oswego County, Investigation of temporary war permit granted Fulton Light, Heat & Power Co. recommended; Northumberland, Saratoga County. Review of revocable permit of Iroquois Pulp & Paper Co. to determine if return is adequate.

St. Louis Engineers Form New Isolated Plant Association

As an aftermath of the controversy over the building of a high-pressure steam plant to serve the Plaza group of municipal buildings at Twelfth and Market Sts., St. Louis, the engineers of St. Louis are organizing an Isolated Power Plant Operating Association. Membership is open to the engineers' associations that took an active part in the recent controversy; that is, the N. A. S. E., the Craftmens Council and the union engineers and as well to any engineer or fireman that does not belong to these associations and to supplymen generally. The object of the association is to back up the isolated plants by making investigation of any particular case, to furnish data where needed, and in general, support the interests of the isolated plant. Funds will be raised by issuing an engineers' "Handy Book" which is to contain a directory of the high-pressure power plants, and engineers of St. Louis and will carry advertising. A membership in the vicinity of 500 is anticipated. The first booster meeting was held on April 24. The Larkin Engineering Co. is to be retained as consulting engineers for the new association.

Stokers Sold for Three Months of 1925

The Department of Commerce announces the following statistics on Mechanical Stokers for the first three months of 1925:

STOKERS SOLD, HEATING SURFACE, AND KINDS OF INSTALLATION

Year and Month	Establishments Reporting (Number)	Stokers Sold Number	Installed Under: Fire-Tube Boilers Number	Fire-Tube Boilers Sq.Ft. Heating Surface	Water-Tube Boilers Number	Water-Tube Boilers Sq.Ft. Heating Surface
1925						
March	13	131	17	24,460	114	686,530
February	13	135	28	49,050	107	413,930
January	13	57	4	8,700	53	270,010

United States and Canada Agree to Study of St. Lawrence River

Joint Board Will Report Army Plan Submitted Last Year—Project Expected to Cost $300,000,000

FINAL AGREEMENT has been reached by the United States and Canada as to the scope of the study by the Joint Engineering Board for the improvement of the St. Lawrence River between Montreal and Lake Ontario, in order to provide access to the Great Lakes for maritime commerce and for the development of water power.

The estimated expenditure would be $300,000,000. The outcome depends largely on the report of the Board which is to be made not later than April 1, 1926. The Board has been directed to report upon the practicability of the plan presented in the report of the Army Board submitted last June. It is also requested to report what alternative schemes, if any, would be better adapted.

Joint Engineering Board Ready to Start Work

With regard to the progress of the Joint Engineering Board, Secretary Hoover stated on April 23rd:

The final settlement of negotiations between the United States and Canada over the program for joint official investigation of the St. Lawrence waterway project marks a decided step in the progress toward determination of the facts and therefore the solution of the problem. The engineering work will start at once, Congress having appropriated $275,000 for the purpose and the Canadian government having made the necessary appropriations. A determination will be made of plans, cost amount of power developed, operating cost and all other engineering facts.

Parallel with this investigation there will also be an investigation which has been directed by Congress and covered by special appropriations, of the projected deep waterway from the Great Lakes to the Hudson River, to determine its feasibility, cost and operating expenses.

These two investigations should be completed within approximately twelve months, and it will then be possible to finally determine national policies and to proceed with active steps in realization of the lakes to sea connection.

Parallel with the engineering investigation, an exhaustive survey of the economic aspects of these outlets from the Great Lakes, the value of the development of electrical power from the St. Lawrence canal and other questions will be continued by the Department of Commerce.

Negotiations over the St. Lawrence have on the American side been carried out by the State Department under the general direction of the St. Lawrence Commission which comprises:

Secretary of Commerce, Herbert Hoover, chairman; William C. Breed, New York City; James P. Goodrich, Winchester, Ind.; James E. Davidson, Bay City, Mich.; Charles L. Allen, Worcester, Mass.; James R. Howard, Chicago, Ill.; James D. Noonan, Washington, D. C.; Stephen B. Davis, Washington, D. C.; Charles P. Craig, Duluth, Minn.

The engineering work will be undertaken for both governments by a joint board of six engineers of whom the American representatives are: Brig. Gen. Edgar Jadwin, assistant chief of engineers; Col. William Kelly, chief engineer, Federal Power Commission, and Lieut. Col. G. P. Pillsbury, all of the Corps of Engineers, U. S. A. The Canadian members are: Duncan W. McLachlan, of the Department of Railways and Canals; Oliver P. LeFebvre, chief engineer of the Quebec Streams Commission, and Brig. Gen. Charles Hamilton Mitchell, of Toronto.

The Joint Engineering Board will at once commence work on the engineering surveys in accordance with their instructions.

The engineering investigation into the Great Lakes-Hudson River Waterway project will be conducted by Col. Herbert Deakyne, Col. Spencer Crosby, and Maj. P. S. Reinecke.

Feather River To Have High-Head Plant

Construction of another high-head hydro-electric plant to cost $8,500,000, the first of six units, on the Middle Fork of the Feather River, in Butte County, Calif., will be started in a few weeks by the Feather River Power Co. At Buck's Creek a dam will be built which will impound 103,000 acre-feet of water. An 8x7-ft. tunnel 26,000 ft. long will carry the water from the dam to the power house. The pressure pipe and penstocks will be approximately 5,000 ft. in length. The effective head will be 2,400 ft. The power house will produce 50,000 hp. The five other units, plans for which have already been drawn, will produce about 400,000 hp. They will cost from $45,000,000 to $50,000,000. The power to be produced by the first unit is under a 35-year contract to the Great Western Power Co.

Boulder Dam Specified in Colorado Compact

The six-state Colorado River compact sponsored by Colorado was ratified with a reservation by the California State Senate on April 2, the measure having previously been passed by the Assembly. Ratification of the agreement was made contingent upon the erection by the federal government of a storage dam at Boulder Canyon.

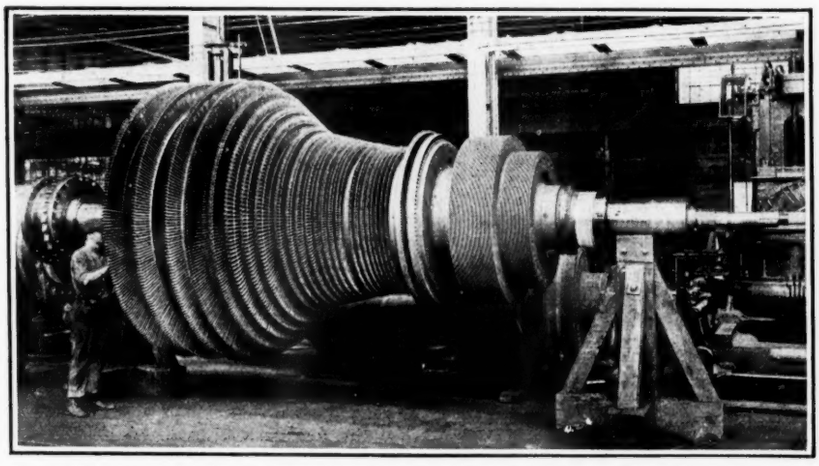
Gennevilliers Adds Two 50-000-Kw. Units

The fuel-electrical plant at Gennevilliers, Paris, France, which was described in *Power*, August 1, 1922, Vol. 56, page 157, is an example of the tendency to employ large units in foreign as well as American plants. This plant, which is owned by L'Union d'Electricite, has a capacity of 240,000 kw. Six groups of turbines of 40,000-kw. capacity each furnish the power at present. Two additional units, each of 50,000-kw. capacity are expected to be put in operation before 1926.

New York Steam Corp. Obtains New Rate Schedule

The Public Service Commission has approved the new schedule of the New York Steam Corp. for steam service supplied in the Borough of Manhattan, City of New York. Schedule filed to become effective April 1, 1925, changes the basis for surcharge of credit to the ratio of 1c. per 1,000 kals* of steam billed to each 10c. increase or decrease in average cost of coal above or below the base price, also changes the rate (per 1,000 kals) in classification for annual power service from 90c. for first 500,000 kals followed by 50c. for all over 500,000 kals up to a specified guaranteed minimum, followed by 90c. for the excess over 500,000 kals consumed but not guaranteed for each monthly period to the following (per 1,000 kals): For first 500,000 kals, 90c.; for the balance of a guaranteed minimum, 50c.; for the first 3,000,000 kals over the guaranteed minimum, 75c.; for all over this 3,000,000 kals, 55c.

*A *kal* is the Steam Corporation's own unit of measurement, and is said to be equivalent to one pound of steam condensed.



45,000-hp. Westinghouse steam turbine for Seal Beach station at Los Angeles

Perkins Unaflow Engine On Exhibit

A full-size replica of the first unaflow steam engine built by Jacob Perkins in 1826-27 was exhibited this year at the National Science Museum, South Kensington, London, Eng. It it understood that schools or experimental engineers may obtain recasts of the cylinder for test purposes at a normal charge.

Coal Consumption and Power Output by Utilities Drops

The average production of electricity by public-utility power plants in February was 178,000,000 kw.-hr. per day, a reduction of less than 1 per cent from the average output for January. In January about 31 per cent of the total output was produced by the use of water power and in February about 35 per cent.

Public-utility power plants in the United States consumed 3,148,549 net tons of coal in February, according to a report by the Geological Survey. This compares with 3,715,744 tons in January. Fuel-oil consumption by utilities in February totaled 999,463 bbl., compared with 1,400,822 bbl. in the preceding month.

New Steam Plant for Utica, New York

Progress is rapidly being made on the new 60,000-kw. Harbor Point station of the Utica Gas & Electric Co. It is expected that the plant will be put into operation during January, 1926. The structure is being built for a capacity of 60,000 kw., but only two 15,000-kw. turbo-generators will be installed at first. These will be followed later by a 30,000-kw. unit. The complete development based on the available cooling water will permit of an ultimate 150,000-kw. development.

The Harbor Point plant itself will have two 15,000-kw. Westinghouse turbo-generators. Four Connelly boilers, of 16,100 sq.ft. each, are to be installed. Each furnace is equipped with water-cooled side walls and bridge wall at boiler pressure. The steam pressure is 275 lb. at the throttle of the machines with 125 deg. superheat. Taylor stokers made by the American Engineering Co. with 14 retorts and 33 tuyères wide, with clinker grinders, are to be used. It is expected that the four boilers will be sufficient for 60,000 kw. capacity. "Elesco" superheaters made by the Superheater Co. are being used.

Two 20,000-sq.ft. C. H. Wheeler condensers serve the two turbo-generators. The circulating water for each condenser will be supplied by two entirely separate pumps, one motor-driven and the other steam-driven. Owing to the soil conditions it will be impossible to use tunnel construction for the circulating water. Two intake lines consisting of 42-in. cast-iron pipe will supply each condenser, the discharge going to a manifold that will be common to the two 15,000-kw. machines and the first 30,000-kw. machine to be installed later. All main station auxiliaries are to be driven by both steam and electricity.

Obituary

George Mesta, president of the Mesta Machine Co., Pittsburgh, Pa., died on April 22 at New York City, after an illness of some duration. He was born in Bethel Township, Allegheny County, Pa., in 1862. After attending local schools and Bethel Academy, Mr. Mesta, went to the Engineering School of the University of Pittsburgh where he graduated in 1885. He then engaged as engineer with Totten & Co., Pittsburgh, designing engines and rolling-mill machinery and in 1887 organized the Leechburg Foundry & Machine Co., becoming vice-president and general manager, and in 1889 was elected president.

In 1898 he organized the Mesta Machine Co., became its president and started building the big plant at West Homestead, Pa. He was a member of the A.I. & S.E.E., A.S.M.E., A.I.M. & M.E., Engineering Society of Western Pennsylvania and other technical and social clubs.

Asa Martinus Mattice, who died suddenly at the Engineers Club, 32 West 40th St., New York City, on April 19, in his seventy-second year, graduated from Annapolis in 1874. He taught in the Naval Academy for several years and was principal assistant to Admiral Melville in the early designs of machinery for the "new navy" (1886-89). Later he was connected with the Calumet & Hecla Co., Westinghouse Electric & Manufacturing Co., Allis Chalmers Co. and the Walworth Co. Although in retirement at the time of the world war, he resumed active duties with the Remington Arms Co. and continued with that organization as advisory engineer up to the time of his death.

He was a member of the A.S.M.E., being one of the Board of Managers 1903-6, the American Society of Naval Engineers and the Engineers Club of New York. He was buried at Buffalo, N. Y., and is survived by a sister and several nephews and nieces.

Personal Mention

A. G. Carson, who has been manager of power stations of the Wisconsin Public Service Corp. since 1918, has been appointed manager in charge of the electric light, power, electric railway and gas departments of the corporation.

Richard John Durley has been appointed secretary of the Engineering Institute of Canada to succeed Fraser S. Keith, who resigned in December to become manager of the Department of Development of the Shawinigan Water & Power Co.

J. P. Growdon, who was in charge of all design on the Skagit River hydro-electric development of the city of Seattle, has accepted a position with the Aluminum Company of America as principal assistant to James W. Rickey, hydraulic engineer at Pittsburgh.

C. Otto von Dannenberg, formerly connected with the electrical division of the engineering department of the J. G. White Engineering Corp., has affiliated himself with Sanderson & Porter as a member of their field engineering staff at Springdale in charge of engineering design.

W. W. Erwin, for the past seven years chief operating engineer of the New York Edison Co., has been appointed controller of the company to succeed C. S. Shepard, who has retired.

S. Murray Jones, formerly connected with the Alabama Power Co., is now in the operating department of the Carolina Power & Light Co. at Raleigh, N. C., in the capacity of engineer.

M. Benson, power-plant specialist and well known as the inventor of the Benson steam system, has recently opened an office in Los Angeles at 509 Bank of Italy Bldg., for the working out of other problems of power.

D. J. Fleming, for many years with the Allis-Chalmers Co., the Westinghouse Electric & Manufacturing Co. and more recently employed by Sanderson & Porter Co., New York City, to value public-utility properties, has joined the engineering staff of R. Ophuls & Hill, Inc., Engineers, 112 West 42nd St., New York City.

F. G. Fleckenger, formerly with the Theodor Kuntz Co., Cleveland, Ohio, has been appointed chief engineer for the new library for the City of Cleveland which is to be ready May 1. **Harry Shackelton,** who was with the same firm, is to be assistant engineer.

Charles S. Foreman, chief engineer and superintendent of the Kansas City, Mo., Water Department, has tendered his resignation effective May 1. Mr. Foreman is to be associated with Smith Bros., Inc., Dallas, Texas, successful bidder for the construction of the Missouri Valley and Turkey Creek Tunnels of the new water supply system of Kansas City.

Society Affairs

The Vancouver Section of the A.I.E.E. will have "Hydro-Electric Developments of the East Kootenay Power Co.," by M. L. Wade, as the subject for its May 1 meeting.

The Baltimore Section of the A.S.M.E. will have as the subject for its May 13 meeting "Recent Developments in Pulverized Coals as Fuel," by R. K. Neade.

The Cleveland Section of the A.S.M.E. will hold its May 4 meeting at Fairmont Pumping Station at 4 p.m. Dinner will be at the Case Club at 6 p.m. The subject of the evening will be, "The Operation of the Modern Municipal Pumping Station," by L. A. Quale, designing engineer of station.

The Empire City No. 1, N.A.S.E., New York City, which is the name chosen for the consolidation of five of the subordinate associations in New York City of the N.A.S.E., as announced in *Power*, Dec. 23, 1924, has elected the following officers: James C. Goodrich, of No. 24, president; H. W. Wright, of No. 15, vice-president; E. A. Price of No. 7, treasurer; R. O. Smith, of No. 1, financial secretary; Evan Davies, of No. 7, corresponding secretary; M. Cullen, of No. 7 conductor; M. Borge, doorkeeper.

The Administrative Board of the American Engineering Council will hold a meeting in Philadelphia at The Engineers Club, May 8-9.

The Affiliated Technical Societies of Boston will hold their third annual dinner at the Boston Chamber of Commerce on April 29. Brig. Gen. H. M. Lord, Director of the Budget, will be the principal speaker.

Business Notes

The Conveyors Corp. of America, 326 West Madison Ave., Chicago, Ill., announces that Edgar C. Walthall has joined the sales organization of the Boiler Equipment Service Co., Chandler Bldg., Atlanta, Ga., district engineers for the company.

The Homestead Valve Manufacturing Co., Homestead, Pa., announces the appointment of the McArdle & Walsh Co., Key Highway at Boyle St., Baltimore, Md., as distributors of its products in the cities of Baltimore, Washington, and surrounding territory.

The Moore Steam Turbine Corp., Wellsville, N. Y., has recently appointed: J. J. Mullan & Co., 50 Church St., New York City, as its New York representative; H. H. Leathers, 80 Federal St., Boston, Mass., as its representative in charge of the New England states.

The Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa., announces changes in the personnel of its power department: A. H. Ganshird, formerly of the condenser section, is to be manager of the turbine section, power division, to succeed D. O. Tylee, transferred to the industrial division, Pittsburgh office; P. L. Fetzer is to be manager of the condenser section to succeed A. H. Ganshird; J. A. Brown is to manage the generator section to succeed W. Loften transferred to the Pittsburgh office, central station division; F. L. Lewis is to be manager of the substation section to succeed B. H. Lytke, transferred to the Philadelphia office.

Trade Catalogs

Interlocks, Robinson—Chas. Cory & Sons, Inc., 183 Varick St., New York City. Catalog bulletin No. 105-29-B describes this system of personnel and equipment protection against improper operation of switching equipment.

Steam Turbine Lubrication. — The Vacuum Oil Co., New York City. Steam turbines of many types, their principles of construction, details of operation mechanisms and especially their lubricating systems are presented to the reader by means of pictures, colored sections and diagrams. Description, however, is only one part of this pamphlet, the remainder being applied to the troubles of turbine lubricating systems, how sludges are formed, and what precautions must be taken in testing turbine oil and maintaining it in good condition. The operating man will benefit much by carefully reading the information contained herein.

Coming Conventions

American Boiler Mfg. Association, H. N. Covell, 7 East 19th Ave., Brooklyn, N. Y. Meeting at Glen Spring Hotel, Watkins, N. Y., June 1-3.

American Institute of Electrical Engineers. F. L. Hutchinson, 29 West 39th St., New York City. Regional convention, at Swampscott, Mass., May 7-9. Annual convention at Saratoga Springs, June 22-26.

American Society of Heating & Ventilating Engineers. F. C. Houghten, 29 West 39th St., New York City. Semi-annual meeting at Traymore Hotel, Atlantic City, June 15-17.

American Society of Mechanical Engineers—Calvin W. Rice, 29 West 39th St., New York City. Spring meeting at Milwaukee, Wis., May 18-21.

American Society of Refrigerating Engineers. William H. Ross, 35 Warren St., New York City. Convention at Milwaukee, May 18-21.

Electric Power Club. S. N. Clarkson, B. F. Keith Bldg., Cleveland, Ohio. Convention at Hot Springs, Va., May 26-29.

Exposition of Inventions—American Institute, E. W. Bartlett, 47 West 34th St., New York City. Exposition at Engineering Societies Bldg., 29 West 39th St., New York City, April 27 to May 2.

Master Boiler Makers Association. H. D. Vought, 26 Cortlandt St., New York City. Convention at Chicago, May 19-22.

Mid-West Power Show at Milwaukee, Wis., May 18-21. Ralph H. Cahill, care of Mid-West Power Show, City Hall, Milwaukee, Wis.

National Association of Stationary Engineers. F. W. Raven, 417 South Dearborn St., Chicago, Ill. National convention and exhibition at St. Paul, Minn., Aug. 31-Sept. 4. Annual conventions and exhibitions of state associations are scheduled as follows: **Kansas Association** at Topeka, May 6-8. J. M. Van Sant, 739 Horne St., Topeka. **Pennsylvania Association** at Pittsburgh, Pa., May 15-16. Frank J. McCarron, 3647 North 11th St., Philadelphia, Pa. **Wisconsin Association** at Milwaukee, May 18-22. F. W. Horn, 256 29th St., Milwaukee, Wis. **Illinois Association at Decatur.** Olaf Jacobsen, 837 Lake Side Place, Chicago. June 3-5. **New Jersey Association** at Atlantic City, June 4-8. H. W. Vail, 1244 Park Ave., Plainfield, N. J. **New York Association** at McAlpin Hotel, New York City, June 11-13, W. T. Meinzer, 3rd St., near Warburton, Bayside, L. I. **Iowa State Association** at Ottumwa, June 16-18. F. L. Stocker, 127 S. Elm St., Ottumwa, Iowa. **New England States Association** at Worcester, Mass., July 9-11, formerly announced July 10-12. F. L. Tyler, 32 Briggs St., Taunton, Mass. **Ohio Association** at Middleton, Ohio, June 18-20. T. S. Garrett, 2622 East Second St., Dayton, Ohio. **Connecticut Association** at New Haven, June 25-27. George F. Klopfer, 30 East Pearl St., New Haven. **Michigan Association at Muskegon,** July 15-17. Charles Unterreiner, 5522 Underwood Ave., Detroit, Mich. **Minnesota Association** at St. Paul, Aug. 24-28. C. A. Nelson, 800 22nd Ave., Minneapolis, Minn.

National District Heating Association. D. L. Gaskell, Greenville, Ohio. Sixteenth annual convention at West Baden Springs Hotel, West Baden, Ind., May 19-22.

National Electric Light Association. M. H. Aylesworth, 29 West 39th St., New York City. Annual convention at San Francisco, June 15-20.

Society of Industrial Engineers. George C. Dent, 608 South Dearborn St., Chicago, National convention at Hotel Winton, Cleveland, Ohio, May 6-8.

Southern Exposition—C. F. Roth, Grand Central Palace, New York City. Exposition May 11-23, at Grand Central Palace, New York City. Formerly announced for January.

Brass—Bridgeport Brass Co., Bridgeport, Conn. "Data Book" No. 16 contains prices and weights of sheet brass, brass rod, wire, condenser tubes, seamless brass and copper tubes.

Stoker—Riley Stoker Corp., Worcester, Mass. "The Harrington Stoker" is described in a catalog recently published. Pictures of the stoker and drawings of specific installations are included.

Elevators, Bucket—The Jeffrey Manufacturing Co., Columbus, Ohio. Catalog No. 410 describes these standardized bucket elevators for service in power houses, industrial plants, coal yards, etc. It is well illustrated and contains tables of capacities and dimensions.

Stokers — Cokal Stoker Corp., 341 East Ohio St., Chicago, Ill. "Specifications for Architects and Engineers, in Cokal," is the title of a six-page folder containing blueprints of the semi-mechanical stoker installed under different types of boilers and tables of dimensions for boiler settings and chimney sizes.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; *mine run* except Pittsburgh gas slack (*Coal Age*):

Bituminous, Net Tons	Market Quoting	April 20, 1925
Pool 1	New York	$2.35@$2.85
Smokeless	Boston	1.59
Clearfield	Boston	1.70@ 2.10
Somerset	Boston	1.85@ 2.20
Kanawha	Columbus	1.35@ 1.50
Hocking	Columbus	1.35@ 1.50
Pittsburgh	Pittsburgh	1.75@ 1.90
Pittsburgh gas slack	Pittsburgh	1.60@ 1.70
Franklin, Ill.	Chicago	2.25@ 2.50
Central, Ill.	Chicago	2.00@ 2.25
Ind. 4th Vein	Chicago	2.15@ 2.35
West Ky.	Louisville	1.25@ 1.50
S. E. Ky.	Louisville	1.15@ 1.50
Big Seam	Birmingham	1.50@ 2.00
Anthracite, Gross Tons		
Buckwheat No. 1.	New York	$2.00@$3.00
Buckwheat No. 1.	Philadelphia	2.00@ 2.75
Birdseye	New York	1.40@ 1.60

FUEL OIL

New York—Apr. 23, light oil, tank-car lots; 28@34 deg. Baumé, 5½c. per gal.; 36@40 deg., 5¾c. per gal., f.o.b. Bayonne, N. J.

St. Louis — Apr. 14, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.85 per bbl.; 26@28 deg., $1.90 per bbl.; 28@30 deg., $1.95 per bbl.; 30@32 deg., $2.00 per bbl.; 32@36 deg., gas oil, 4.8c. per gal.; 38@40 deg., 5.5c. per gal.

Pittsburgh—Apr. 20, f.o.b. local refinery; 30@34 deg. fuel oil, 6c. per gal.; 36@40 deg., fuel oil, 6¼c. per gal.

Dallas—Apr. 18, f.o.b. local refinery, 26@30 deg., $1.55 per bbl.

Philadelphia—Apr. 16, 28@30 deg. $2.31@$2.373 per bbl.; 18@22 deg., $2.184@$2.247; 13@16 deg., $2.06@$2.123 per bbl.

Boston—Apr. 18, tank-car lots, f.o.b. heavy oil, 12@14 deg., Baumé, 4⅝c. per gal.; light oil, 28@32 deg. Baumé, 6c. per gal.

Cincinnati — Apr. 21, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5¾c. per gal.; 26@30 deg., 6c. per gal.; 30@32 deg., 6¼c. per gal.

New Plant Construction

Calif., Bakersfield—Benham Ice Cream Co., 1420 H St., will build a two story ice cream plant, on Chester Ave., by day labor. Estimated cost $100,000.

Calif., Beverly Hills—Globe Ice Cream Co., 230 West Jefferson St., Los Angeles, is having plans prepared for the construction of a 4 story, ice cream factory, with ice plant, hardening plant, etc., at Santa Monica Blvd. and Alpine Dr., here. Estimated cost $250,000. Complete refrigerating equipment will be purchased. J. Hausfelder, 230 West Jefferson St., Los Angeles, is engineer.

Calif., Los Angeles—Good Samaritan Hospital, c/o R. D. Johnson, Union Bank Bldg., Archt., is having preliminary plans prepared for the construction of an 8 story, hospital, on Shatto St. Estimated cost $1,000,000.

Calif., Oakland—County of Alameda, will soon award contract for the construction of a power house, garage, etc., for county hospital. Estimated cost $200,000.

Calif., Oakland—R. A. Herrold, Forum Bldg., Sacramento, Archt., is receiving bids for the construction of a 5 story hospital, at Webster and Summitt Sts., for the Providence Hospital, here. Estimated cost $500,000.

Calif., San Jose—Security Warehouse & Cold Storage Co., 350 North 1st St. awarded contract for the construction of an ice plant near 2nd St. to Morrison Bros., 76 West San Antonio St. $35,000.

D. C., Washington—Navy Dept., Bureau of Yards and Docks, will receive bids until May 6, for four 300 hp. watertube boilers, etc. (Spec. 5082).

Ill., Chicago—D. Shetnitz, c/o F. H. Bartlett Co., 69 West Washington St., plans the construction of a 7 story apartment at 61 East Goethe St. Estimated cost $1,000,000. Architect not selected.

Ill., Chicago—Singer Sewing Machine Co., 39 South La Salle St., is having plans prepared for the construction of a 10 story, office building, on State St. Estimated cost $500,000. Munie & Jensen, 39 La Salle St., are engineers and architects.

Ill., Chicago—Y. M. C. A., S. O. Houser, Bus. Mgr., 19 South La Salle St., is having plans prepared for the construction of a 19-story hotel, at 522 South Wabash St. Estimated cost $1,000,000. Berlin & Swen, 19 South La Salle St., are engineers and architects.

Ia., Des Moines—Northland Milk & Ice Cream Co., 11 West 28th St., Minneapolis, Minn., awarded contract for the construction of an ice cream factory at Sixth and Grand Ave., to W. F. Kuchars, 622 Hubbell Bldg. Estimated cost $50,000.

Ia., Diagonal—City will soon take bids for water works system, including pumping equipment, mains, etc. Estimated cost $24,000. W. B. Rollins & Co., 521 Railway Exchange Bldg., Kansas City, Mo., are engineers.

Ia., New Albin—City voted $23,000 bonds for water works pumping equipment, mains, etc. H. R. Green Engineering Co., Cedar Rapids, is engineer.

Ind., Gary—Bd. of Public Works, M. Maloney, Clk., will receive bids until May 4 for the construction of a pumping station, and appurtenant work. Alvord, Burdick, and Howson, 8 Dearborn St., Chicago, Ill., are consulting engineers.

La., Bossier City—Town Council will receive new bids until May 8, for two 110 hp. gas engines, two 500 g.p.m. triplex pumps, two 400 cu.ft. air compressors, with 30 x 56 ft. pump house, etc., for waterworks, also 15 in. flap valve centrifugal pump, lift station, etc., for sewage plant. E. T. Archer & Co., City Bank Bldg., Shreveport, are engineers.

Mass., Monson—Lockwood, Greene & Co., Engrs., 24 Federal St., Boston, are receiving bids for the construction of a 91 x 195 ft. factory with boiler house and engine room, etc., for A. D. Ellis Mills, Inc.

Mich., Clawson—Village plans the construction of waterworks, including centrifugal pump, 500 g.p.m., at head of 140 ft., etc. N. H. Huntley, is engineer.

Minn., St. Cloud—Minnesota Power and Light Co., Duluth, plans the construction of a power dam, 16,500 hp. capacity, across the Mississippi River, 15 miles north of here. Estimated cost $2,000,000. The project will be strictly hydro development, with no steam turbine generating system.

Minn., Hibbing—Power Board, R. Regan, Chm., awarded contract for the construction of 40 ft. addition to power house, and installation of 3 boilers, stokers, and ash conveyors, to Phelps-Drake Co., $289,000.

Minn., St. Paul—Northern Pacific Ry. Co., Railway Bldg., plans the construction of a group of buildings, including boiler plant, shops, etc., at Commercial and East 3rd St. Estimated cost $85,000. O. M. Rognan, 1228 Railway Bldg., is engineer.

Mo., Ash Grove—City, F. D. Conner, Clk., voted $50,000 bonds for waterworks improvements, including pumping equipment, tank on tower, etc.

Mo., Crane—City is having preliminary plans prepared for the construction of water works system, with pumping equipment, tank on tower, etc. C. A. Haskins, 822 Finance Bldg., Kansas City, is engineer.

Mo., Maryville — State Legislature has appropriated $260,000 for new training school, and repairs to power plant for Northwest State Teachers College, here.

Mo., Steele—City, A. B. Rhodes, Clk., will soon receive new bids for waterworks improvements, including two 125 g.p.m. motor-driven pumps, 75,000 gal. tank on tower, etc. Estimated cost $30,000. Former bids rejected. A. C. Moore, 222 Industrial Bldg., Joplin, is engineer.

Neb., Milford—City voted $23,000 bonds for a water works system, including pumping equipment, distribution mains, etc.

Neb., O'Neill—City plans the construction of a 4,000 hp. hydro-electric plant, on Nebraska River. Estimated cost $450,000.

N. J., Jersey City—O. H. Albanesius, 2465 Boulevard, will soon receive bids for the construction of a 16 story apartment with steam heating system, at Boulevard and Gifford Ave. Estimated cost $1,000,000. Sharpe, Bready & Peterkin, 50 East 42nd St., New York, are engineers and architects.

N. J., Trenton—State Board of Education, plans to install coal burning apparatus, to replace oil burning equipment, in State Normal School. Guilbert & Betelle, Newark, are architects.

N. Y., Brooklyn—Brooklyn Eye and Ear Hospital, 94 Livingston St., is having preliminary sketches prepared for the construction of a hospital building, with steam heating system. Estimated cost $1,000,000. Crow, Lewis and Wick, 200 Fifth Ave., New York City, are architects.

N. Y., Mount Pleasant—Bd. of Supervisors, of County Hospital, F. L. Merritt, Clk., Court House, White Plains, will receive bids until May 4, for additions and alterations to boiler plant and pumping equipment, of Grassland Hospital, here. J. F. Musselman, 101 Park Ave., New York City, is consulting engineer.

N. Y., New York—V. Astor, 23 West 26th St., awarded contract for the construction of a 15-story office and stores building on 33rd St. and 5th Ave. to Marc Eidlitz & Son, 30 East 42nd St.

N. Y., New York—Dept. of Plants and Structures, Municipal Bldg., plans the construction of a boiler plant at 731 East 61st St. Estimated cost $125,000. R. E. Hawley is dept. engineer.

N. C., Chapel Hill—University of North Carolina, H. W. Chase, Pres., plans the construction of heating plant and laundry. Estimated cost $125,000. Atwood and Nash, are engineers.

N. C., High Point—J. W. Hendricks, Mayor and City Council, will receive bids until May 7, for furnishing and delivering 4 motor driven and 2 gasoline engine driven centrifugal pumping units with starters, and appurtenant equipment. Also for construction of addition to River and City pumping stations, filter plant, etc. W. C. Olsen, Raleigh, is consulting engineer.

N. C., Scotland Neck—City, B. White, Mayor, plans improvements to power plant, including installation of 500 hp. horizontal boiler outfit, soot blower, etc.

N. C., Thomasville—Thomasville Furniture Co., R. L. Lambeth and J. R. Meyers, plans additions to double the capacity of factory, including electric plant and boiler room. Estimated cost $60,000.

O., Cleveland—C. E. Taft & Son, 3160 West 106th St., are in the market for a H. R. T. 100 to 80 hp. boiler.

O., Youngstown—Bd. of Control will soon receive bids for 16,000,000 g.p.d. pump for filteration plant, and 10,000,000 g.p.d. pump for pumping station. Estimated cost $125,000. H. F. Kaercher, is waterworks superintendent.

Okla., Banchard — City voted $35,000 bonds for waterworks improvements, including deep well, pump house, etc. Gantt-Baker Co., 1116 West Main St., Oklahoma City, is engineer.

Okla., Hinton—Board of Trustees plans improvements to electric light plant and system. Estimated cost $30,000. Benham Engineering Co., Kansas City, Mo., are consulting engineers.

Okla., Marland—City voted $20,000 bonds for water works, including well, deep well pump, tank on tower, etc. Estimated cost $20,000.

South Carolina—Southern Power Co., Charlotte, N. C., W. S. Lee, Pres., has had plans prepared for the construction of a hydro-electric plant, to develop 50,000 to 60,000 hp., on Rocky Creek in Lancaster County, S. C. Estimated cost $1,250,000.

S. C., Aiken—J. L. Williamson plans the construction of saw mill and milling plant. Steam equipment and machinery will be purchased.

Tenn., Knoxville—City Council, L. Brownlow, Mgr., plans the installation of refrigerating system, in municipal market. Estimated cost $30,000.

Tex., Abilene—W. G. Swenson, et. al. is building a 25 ton ice plant. Estimated cost $45,000.

Tex., Bristol—People's Gin Co., is in the market for 30 or 35 hp. center-crank or right hand steam engine (used.)

Tex., Dilley—City will receive bids after May 1, for the construction of a waterworks system, including pumping equipment, tank on tower, etc. Estimated cost $60,000. Terrell Bartlett Engineers, 612 Calcasieu Bldg., San Antonio, are engineers.

Tex., Houston—J. Oppenheimer, A. Kronkosky, W. Emerson, c/o San Antonio Drug Co., 308 Market St., San Antonio, will soon receive bids for the construction of a 6 story, theater and office building, including steam heating and ventilating systems, 2 elevators, etc., at Main St. and McKinney Ave. Estimated cost $1,500,000. The Kelwood Co., Travis Bldg., San Antonio, is engineer.

Wis., Beaver Dam—Beaver Dam Fibre Co., O. Olman, Juneau, Secy., will build a 72 x 130 ft. hemp plant, by day labor here. Estimated cost $50,000. Special machinery and electric motors will be purchased. Private plans.

Wis., Cobb—Village, W. W. Kobb, Clk., voted $15,000 bonds for waterworks, including pumping equipment, mains, etc.

Wis., Green Bay—Allonez Township, J. Du Charne, R.6, Town Clk., will receive bids until May 2, for the construction of a waterworks system, near here. Machinery and equipment including 500 g.p.m. motor driven pumps, gasoline driven auxiliary outfits, 100,000 gal. tank on tower, etc., will be required. McMahon & Clarke Engineering Co., Menasha, is engineer.

Wis., Ladysmith—Ladysmith Milk Producers Assn., E. C. Steube, Mgr., is in the market for refrigerating machinery and dairy equipment.

Wis., Waupaca—F. A. Houseman, Clk. will soon receive bids for a 900 g.p.m. water pump.

Ont., Kirkland Lake—Teck-Hughes Gold Mine, plans to increase output of mine from 100 to 250 tons per day, and will purchase motors, pumps, crushers, etc., electrically driven. Estimated cost $200,000.

Ont., Peterborough—City, S. A. Armstrong, Clk., City Bldg., will receive bids until May 6, for equipment for activated sludge sewage disposal plant, including construction of sewage pumping station, furnishing and installing 3 sewage pumps, 3 air compressors, complete with motors, etc. Estimated cost $75,000. R. H. Parsons, City Hall is engineer.

Ont., Welland—Town has had plans prepared for the construction of a waterworks filtration plant, four 1,500,000 g.p.d. filters, reservoir, electric low lift pumps, etc. Estimated cost $300,000. W. Chapman, Mail Bldg., Toronto, is engineer.